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ETHERIC TELEGRAPHY.

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On November 9th, 1892, I sent a message from London to Mr. Gavey at Cardiff, announcing the death of Mr. Graves, my predecessor at the Post-office. It was sent to him to Flat Holm, an island in the Bristol Channel, across a space of 3·3 miles without any intermediate conductor. On July 3rd of this year I received in Wales the following message from Lord Kelvin:—"This is sent commercially paid at Alum Bay for transmission through ether." It passed through space from Alum Bay to Bournemouth. It was sent by wire to London from Bournemouth. In each of these cases wires were used at the terminal points to control, direct, and transform the energy used, but the medium for the transmission of the disturbances that were translated into words was the ether. It is therefore not correct to call the system "wireless telegraphy." The Germans call it "spark telegraphy," but the title that I have given to the paper is, I think, a better and truer term.

Lighthouses indicate their identity to passing ships by various kinds of signals, either fixed or variable, by occultations or flashes, arranged in groups. Agamemnon, according to Æschylus, signalled the fall of Troy to Clytemnestra at Argos by flashing eight fires and seven intervals. The army is supplied with Sir Henry Mance's heliograph, which signals by sunlight during the day and by flashes of artificial light by night from hill to hill, when the forces are out of reach of other telegraphs. Mr. Marconi recently established communication between the Queen at Osborne House and the Prince of Wales on board the Royal Yacht Osborne in Cowes Roads. He uses virtually the same means. There is no difference but one of degree between those waves that are called light and those that are called electric. The most splendid generalisation of modern days is that of Maxwell, who established the identity of the two, and no experiments are more far-reaching than those of Hertz, who proved the existence and measured the length of the electric waves. Light waves, that is those that affect the eye and give us the sensation called light, are measured in billions per second, and the yellow wave of sodium measures ·0000244in. from crest to crest. Hertzian waves are measured in thousands per second, and they may measure from crest to crest anything from a yard to a mile. Whether the waves be light or electric, or whether they be mere electro-magnetic disturbances, such as those that produce inductive effects, the medium for their transmission is the same universal and incomprehensible medium, the ether.

Morse as early as the year 1842 experimented upon crossing "broad rivers or other bodies of water without wires." An excellent account of his attempts is given in Alfred Vail's early book on the "Electric Magnetic Telegraph," published in Philadelphia in 1845. David Lindsay, a native of Dundee, proposed the samething in 1853. He came up to London with his great invention, and I experimented upon it in Percy Wharf, the store place of the Electric Telegraph Company. The water of a tank, it might have been a river, or achannel, was made to form part of the circuit. It was quite successful, but in those days it was quite useless. In more recent times it has been much used in India. An interesting paper on the subject was read before the Society of Electrical Engineers on March 27th, 1890, by Mr. Melhuish.

The Isle of Wight is connected with the general telegraph system by a submarine cable, which crosses the narrow channel at Hurst Castle near the Needles end of the island. This cable was ruptured in 1882, and as the telephone had shown itself to be such an exquisitely sensitive receiver, it was used to repeat the experiment of Lindsay. Two large metal plates were immersed in the sea at Hurst Castle and Sconce Point, 1¼ mile apart, and two others at Southsea and Ryde, 6¼ miles apart. There were twenty miles of wire in Hampshire, and sixteen in the Isle of Wight completing the circuit. Rapid alternations of current produced a musical note in the telephone, and this was broken up into the dot-and-dash alphabet, which is the basis of the Morse system. Signals successfully passed between Southampton and Newport, but the cable was repaired, and it has not since been broken. Major Cardew, R.E., introduced in 1886 a similar system with our military telegraphs, and it is much used to bridge over broken or badly insulated wires.

The magnetic instruments used in observatories and laboratories to record the variations of the magnetic force of the earth are remarkably sensitive to currents of electricity. Those in Greenwich have been disturbed by currents that leaked from the system of the City and South London Railway, while in Washington and Toronto magnetic observations had to cease owing to the disturbances created by the electric railways in those districts.

The earth is used so much as the return circuit for so many purposes—telegraphic, railway signal, and for the distribution of time—that the telephone used on single-wire circuits having the earth as return at once gave evidence of these vagrant currents by perplexing ticks and sounds of various characters. Professor Trowbridge, of Harvard University, detected the ticking of time signals some miles away from their source. The telephone wire extended along the line of flow of these earth currents and picked them up. Mr. Willoughby Smith, whose father had experimented as far back as 1888, has established permanent communication with the Fastnet lighthouse since 1895 by similar means.

All these effects are due to the fact that the earth is a conductor, and that electric currents flow through it according to definite laws. These earth currents are readily picked up by telephones.

The Post-office wires pass underground through London in iron pipes. They are insulated with gutta-percha. The Telephone Company's wires are overhead on the housetops. The two systems are distinct and separate, and along the Gray's-inn-road, where they run parallel to each other, they are separated by a distance of 80ft. An old telegraphist in the employ of the Telephone Company read a message going to the North of England upon the telephone fixed upon one of the circuits going down the Gray's-inn-road. This was in 1883. This being a serious matter—for it involved the question of secrecy of telegrams—I took prompt and energetic measures to determine its cause and to seek its remedy. Naturally the first conception was that it was due to some contact or to some act of conduction between the two circuits. No such cause could be discovered. The effect was independent of weather. It became clear that it was an effect of induction through the space separating the circuits, and this was easily proved by making the circuits metallic, and quite independent of the earth. Induction involves the presence of the ether as the medium for the transmission of those disturbances or waves which are set up by the activity or energy of currents in the one body—the *inducer*, and their incidence upon the other body, the *induced*—where the energy is transformed again into currents. Thus the rapid rise and fall of electric currents in a telegraph wire disturb the ether surrounding that wire, and if a second wire—a telephone—be near, or parallel to the first, these disturbances or waves of ethereal energy impinging on the matter of the telephone wire are transformed again into electric currents, which give indication of their presence upon the telephone. Curious sounds, like the pattering of hail on a window pane were common enough on telephones, and the overhearing of conversations between other users of telephone circuits were not infrequent in early days. These disturbances were the result of induction. Their removal was quite simple, and it was effected by making the circuits metallic. When this was done the disturbances ceased. But the inquiry led to much speculation, and to the suggestion that by utilising the ether we could communicate across space without the necessity for cables or conductors. It would be tedious to narrate the series of inquiries and experiments that were made in London, Newcastle, across the Severn, the Mersey, in the Conway estuary, and in the Bristol Channel, to determine the laws that regulate the distance to which inductive effects could be appreciated across the ether. These investigations were duly reported periodically to the British Association at their annual gatherings, and a summary of the past ten years' work was submitted to the Electrical Congress held at Chicago in 1893—the year of their great exhibition. A practical system of telegraphy was evolved, and when the cable connecting the island of Mull with Argyleshire was broken down in March, 1895, communication was maintained by this new etheric system. More recently a permanent working system has been established by the Post-office for the use of the War Department between Lavernock, near Cardiff, and Flat Holm, an island in the Bristol Channel, 3·3 miles away from the shore. This is in daily use, and is most effective. All the earlier experiments were made with coils of wire, and with metallic circuits embracing wide areas, but it was soon found that single wires dipping in the earth at each end were equally effective, and at shorter distances gave better results. Across Loch Ness, a distance of one mile and a-quarter, it was found possible to speak by telephone. Earth conduction came in as a friend to assist the result, but it is very easy to show that the prime effect is etheric. A gutta-percha wire floating on the surface of the sea three miles away, with its ends making earth in the sea, is affected, and emits sounds; but if it sinks below the surface all sounds instantly disappear, and the telephone ceases to be affected. If the alternations of current be produced either by a dynamo or by a battery, and the sounds received at a distance of 3·3 miles, then because the rise and fall of the currents from the battery are so much quicker and abrupt than those from the dynamo, a current of one-tenth the strength will produce equal effects. Hence, batteries are now used, and the result shows that the effects are inductive and not conductive. Conductive effects are distinctly observable at distances of three miles. Hence, for all distances within this radius the use of the earth becomes beneficial, and is the reason why my electro-magnetic system is so essentially practical. It is so little used because it is so little wanted. It failed, however, to establish communication with a lightship when a coil of cable connected with the shore lay on the bottom, and another coil surrounded the ship on the outside of the hull, even though the distance separating the two was only a few hundred feet. The energy was absorbed by the sea water. Experiments in air were perfectly satisfactory, and it was disappointing to find the sea water so opaque to these etheric waves.

In 1887 I gave an empirical law which indicated the distance to which it was possible to signal:—

$$C_2 = \frac{C_1 l}{d^2 r_2} \times M,$$

C_1 and C_2 being primary and secondary currents, l length of primary line, r_2 resistance of secondary current, d distance between circuits, M a constant dependent on frequency of alternations, and rate of rise and fall. This showed that with a line 10 miles long, carrying 100 ampères, it would be possible to communicate through nineteen miles with the apparatus we then had in use. We could probably double that distance now.

In the autumn of 1896 a young Italian—Marconi—called at the Post-office with an introduction to describe to me a new plan of his own for utilising the so-called Hertzian waves, whose existence was predicted by Clerk-Maxwell, but which were made evident in a brilliant manner by Hertz. Mr. Marconi had experimented with his system upon his father's estate near Bologna, and had obtained satisfactory results at considerable distances. No one in Italy would at that time consider his system, so he came to his mother's native land, whose language he spoke with fluency, to try his fortune. The idea was perfectly novel to me. It differed from the system in use, inasmuch as it required no long base lines or large areas embraced by wires to distribute and pick up the electric magnetic disturbances due to the rapid rise and fall of electric currents. The apparatus at the terminals was neat and compact. It could be placed on the top of a tower, on the deck of a ship, on the roof of a house. It was eminently adapted to communicate with a lightship.

Mr. Marconi wanted simply the air. He excited this air-space with electric impulses of very high frequency by means made familiar to us in England by Professor Oliver Lodge, who has been such a clear expounder and developer of the work of Hertz, and who very nearly anticipated Mr. Marconi. These waves permeate space just as light waves do, and the distance to which they extend is apparently unlimited, but the distance at which they are recorded depends simply on the delicacy of the apparatus—the electric eye—used to detect their presence. The waves are excited by an ordinary induction coil such as is used for producing sparks in vacuum tubes or the now well-known Röntgen rays. They are directed into space by a conductor—a wire or rod—fixed vertically to a mast or suspended by a kite or balloon. They are received by a similar suspended conductor connected to an extremely delicate detector, discovered by Branly, called by Oliver Lodge a "coherer," and developed into a new and beautiful telegraph relay by Marconi. This relay consists of a small glass tube about 1in. long and ⅛in. in diameter, into whose ends two silver pole pieces are tightly fitted, separated from each other by about $\frac{1}{50}$in.—a thin air space or disc—which is lightly filled up with a mixture or powder of fine nickel and silver filings. The tube is then exhausted to a high vacuum and sealed. In this normal condition the metallic powder is an insulator; it allows no current to pass through it. But let an electric impulse fall upon it; its condition changes, order is impressed upon its discordant ranks, it is polarised or oriented or marshalled in serried array. It becomes a conductor; it coheres, and allows a current to pass. This will continue until it is tapped or mechanically shaken, when it instantly returns to its previous insulating state. It is, in fact, decohered. Marconi decoheres by making the current itself vibrate a small hammer against the glass tube, which in striking emits a sound. Such sounds can be formed rhythmically into a telegraphic language, or the current so set up can actuate a Morse or Kelvin recorder and print the messages sent in dot-and-dash letters.

After some preliminary trials early in the summer of last year upon Salisbury Plain, Mr. Marconi conducted a series of experiments, under my own personal inspection, between Lavernock and Brean Down across the Bristol

Channel, a distance of nearly nine miles. The signals were excellent and very promising. Subsequently, towards the end of the year, experimental trials were conducted between Alum Bay, in the Isle of Wight, and Bournemouth, as well as Swanage. A small steamer cruised about the neighbourhood and exchanged signals, to distances of about fifteen miles. Mr. Marconi finds communication between ship and ship easier than between ship and shore. Neither fog nor rain, wind nor storm, snow nor hail, impedes this communication, In July last the *Dublin Daily Express* published daily reports of a regatta taking place at Kingstown, signalled from a moving steamer that followed the races in Dublin Bay. More recently over one hundred messages passed between the Queen at Osborne House and the Prince of Wales as he lay invalided on board the royal yacht Osborne in Cowes roads.

"Lloyd's" are using it to signal passing ships from Rathlin Island in the north of Ireland. Distances of twenty-five miles have already been bridged, and experiments are going to be made by Mr. Marconi between Dover and Calais, which can scarcely fail to be successful. There would be no difficulty in communicating by my systems across this distance.

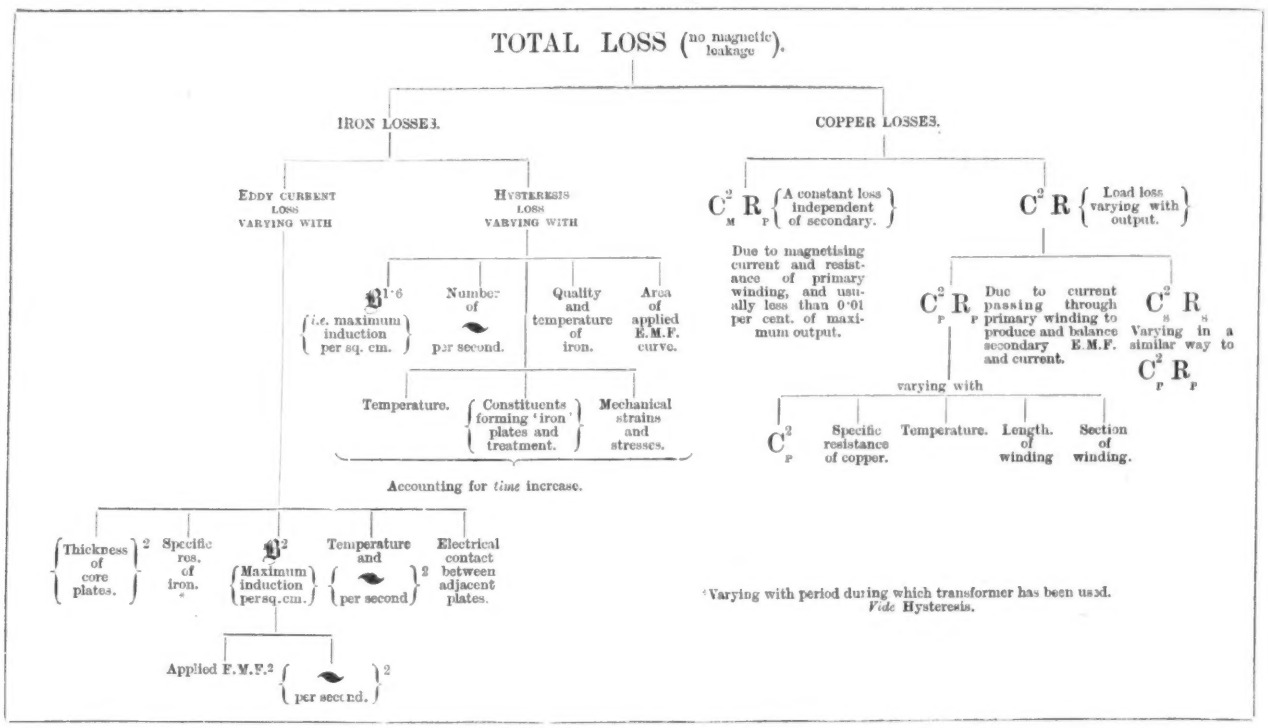
It is quite clear that etheric telegraphy is practical, but the field for its use is limited, except if it be made practical between ship and ship and between ship and shore. This is the region where the system would not only be useful but beneficent.

TRANSFORMERS IN PRACTICE.

THE battle of the systems to be adopted for the supply of electric current, whether for power or lighting, has now been waged for some years, and with varying fortune, leaning sometimes towards the low-tension noyances which are inseparable from the active working of any central station for the supply of electric energy. Indeed, hardly any engineer of position to-day defends the intermural station, and recent events in the Committee-rooms of the House of Commons prove that great efforts are being made by many of the largest of the supply companies and corporations to shake themselves clear of all the drawbacks which surround them, within the business or residential districts of our great conglomeration of cities called London. The London Electric Supply Corporation, the pioneer of them all, has its great station away on the river bank at Deptford, where injunctions are unknown, and where even smoke is but gently anathematised. The Metropolitan Company is hurrying itself off to Willesden as rapidly as it can, for it has had enough and to spare of Manchester-square, Sardinia-street, and Whitehall-court. The City of London Company is "outside the walls," but close to them—perhaps too close to them—at Bankside. The Strand Electricity Supply Company, more familiarly known as "Gatti's," is making a step, though it is a very short one, in the right direction, and either "Gatti's" must limit their ambition or make up their composite minds to take another step, which ought to be a giant stride in the future. The Westminster and St. James's companies are also uneasy in their various seats, and sigh for fresh fields and pastures new, where near to running water they may erect a station or stations far from the madding crowd of Pall Mall and Bond-street, of Whitehall and Piccadilly. The lighting of London grows apace, and though we are becoming accustomed to hear of how slow its progress is in this great city by comparison with its speed and enterprise in many of the towns and cities of the Continent, and even with many a little Swiss or Irish village, we should be surprised indeed were we enabled to get a glance at the books of some of the companies named above, to see the thousands of names of would-be consumers who are patiently, or the reverse, awaiting their turn to be switched on. It is easy to make a brave show in Ballymena, but not so simple in the metropolis of the world. Great difficulties have had to be overcome in our alternating-current central stations—difficulties which cannot be understood by the simple-minded one-horse power low-tension continuous-current engineer. Electrical science has advanced by leaps and bounds during the past few years; the old string-and-brown-paper electrician is departing, and in his place a new order of man appears, one who is not all electrician and no mechanician, but one who combines with his electro-technical knowledge his mechanical experience.

Quiet firmness and patient determination are the characteristics of our British engineers. They are never too old to learn, never so obstinate that they will not cheerfully go back upon their path if it is shown to lead them in a wrong direction; and, unlike many continental and nearly all American engineers, they are well content to let their work speak for itself, being satisfied that it needs no puffing. If we listen to many an engineer from the other side of the Atlantic boasting, we shall come to the conclusion—unless we know better—that we in this country sit at their feet, and endeavour to sip in whatever overflows from their superabundance of knowledge and experience. But if we go round London with our American friend and show him something of what is being done, and note his silence, we then realise that much of what he sees comes as a shock to him, for, until he came over here, he had honestly thought us to be as much behind the American engineers as he now finds us to be ahead of them. He will look at Deptford, and see great work being quietly done without boasting, and he will think of Niagara, and even his assurance will not overcome his knowledge, that they had let "I dare not wait upon I would" in the question of the pressure at which the alternators should generate; and he will only cheer up again when someone reminds him of faint hearts even here in London, which have been so retrograde as to contemplate a low-tension generating station, though with high-tension transmission, and who have placed the order for alternators and engines at his side of the Atlantic. It only remains for the owners of these faint hearts to import engineers to run the plant.

In no branch of electrical science has more thought, more study, more experiment, and more energy been expended than in the improved design and manufacture of transformers since the year 1883, when Messrs. Gaulard and Gibbs seriously went into the use of alternating-current distribution by means of what had hitherto been known as an induction coil. It is true that Faraday over fifty years before that date used an induction coil, which was the prototype of the modern transformer; but during all those years no practical use had been made of the discovery, although many scientists from Masson, who first used iron wires as a core, to Ruhmkorff, and down to Jablochkoff, had been working in the direction. Messrs. Gaulard and Gibbs used the coils of their earlier transformers in series, the primary current being maintained as constant as possible, while the pressure was varied. Between 1883 and 1885 considerable progress had been made, and owing to the investigations and experiments made by Kennedy, Zipernowsky, Ferranti, and Kapp, the older order was changed; the transformer was found to be a perfect self-regulating instrument when put in parallel, the pressure being then kept constant and the current varied, the old series system was discarded, and the parallel system universally adopted. Zipernowsky claims to have been the first to do this, protecting himself by taking out a patent for it, but his claim is doubtful, and is certainly repudiated by nearly every user of alternating currents, and by practically every maker of transformers. As the whole question is


TOTAL LOSS (no magnetic leakage).
IRON LOSSES.
COPPER LOSSES.
EDDY CURRENT LOSS VARYING WITH
HYSTERESIS LOSS VARYING WITH
$C_M^2 R_P$ { A constant loss independent of secondary. }
$C^2 R$ { Load loss varying with output. }
Due to magnetising current and resistance of primary winding, and usually less than 0·01 per cent. of maximum output.
$B^{1\cdot6}$ { i.e. maximum induction per sq. cm. }
Number of ~ per second.
Quality and temperature of iron.
Area of applied E.M.F. curve.
$C_P^2 R_P$ Due to current passing through primary winding to produce and balance secondary E.M.F. and current.
$C_S^2 R_S$ Varying in a similar way to $C_P^2 R_P$
varying with
Temperature.
{ Constituents forming 'iron' plates and treatment. }
Mechanical strains and stresses.
C_P^2 Specific resistance of copper.
Temperature.
Length of winding
Section of winding.
Accounting for *time* increase.
{ Thickness of core plates. }^{2}
Specific res. of iron.
B^2 { Maximum induction per sq. cm. }
Temperature and ~ per second ^{2}
Electrical contact between adjacent plates.
Applied E.M.F.^{2} { ~ per second. }^{2}
* Varying with period during which transformer has been used. *Vide* Hysteresis.

continuous cult, and then swinging over to that of the more progressive high-tension and extra high-tension transformed current. The apostles of low tension have, however, now had their best day, and that system is being relegated to the uses for which it is best adapted. Small towns, in which the radius of supply is severely limited, and a central position for a generating station can be secured, will naturally continue to favour the low-pressure system; and the greater ease and lesser knowledge required for its application will probably always render it the more economical and simple system for use in isolated private country houses, or in works or public institutions. Its advantages also cover the efficient charging of secondary batteries or accumulators; and it gives a more satisfactory account of itself in the running of motors, and in the efficiency of the light supplied from its arc lamps. As the child is to the man, so is the low-tension system to the high; and as the man can generally do all that is possible for the child, although it may be more ponderously, so may it be safely said that everything that can be done by a low-tension supply can be equally well done by an alternating current, though perhaps with a little more complication, while still possessing all its own preponderating advantages. Electric current at high and extra high pressures, 10,000 volts and upwards, can be generated directly from the alternator, and may be transmitted over many miles with trifling loss, through small conductors, the cost of which is comparatively slight; and such current may be used at the most distant point from the alternator, for the purpose of driving synchronous or non-synchronous alternating-current motors, upon the shafts of which may be carried continuous-current dynamos for the charging of batteries or accumulators, the supply of arc lamps, or for such testing or other work as may be required. Indeed, we may repeat, that for all uses the alternating-current system is available, either immediately or indirectly, and it therefore becomes a difficult problem to justify the existence, within city limits, of the multifarious an-

likely to be fought out in the Law Courts in the near future, for Zipernowsky has practically taken the field against the world, we may look forward to a speedy solution of one of the most serious difficulties which has threatened electrical industry.

The use of alternate-current transformers may be said to date from the period at which it was found necessary to transmit and supply electrical energy over long distances and large areas, the main use of the transformer being to convert comparatively small currents generated and transmitted to distributing stations at a high voltage into heavier currents at a pressure of 100 volts or 200 volts for conversion into light or mechanical power. Such a transformation, it will be readily seen, is different from that effected by dynamos and motors, in that in the latter case mechanical energy is converted into electrical energy, and *vice versâ*, whereas in the former electrical energy of one potential is changed into electrical energy of another potential. During this transformation, as, indeed, in all others, a certain waste of energy occurs, and it is the magnitude of such loss which determines almost exclusively the efficiency of distribution from an alternating current generating station. It will be seen, from a very graphic table, which we reproduce from *Lightning* of December 16th, 1897, and which was got out by Mr. A. F. Berry, for many years on the staff of the London Electric Supply Corporation, and now managing engineer to the British Electric Transformer Manufacturing Company, how these losses are made up:—

In further explanation of his table Mr. Berry says in the same issue:—"In considering the design of transformers it is well to glance through a table, such as the one given here, demonstrating how the waste energy in transformers is accounted for. This table may, I hope, be of use and interest to those who have but little time to devote to this subject. The object of a table of this description is to render it possible for any one interested to comprehend a somewhat complicated subject, and to

observe the way in which the tributaries combine to form one total, and, conversely, to know how the various factors split up and are dependent on other factors. The equations—theoretical and empirical—connecting various extremities to the limbs, and the limbs in turn to the trunk representing the total summation, are to be found in the numerous text-books and papers published on the subject, when calculations have to be made. The table is given in its present form to indicate the conditions that influence the loss of energy, and that have therefore to be borne in mind in transformer design. The application of tables such as this to work involving estimating, designing, calculating, &c., renders such work less laborious, and in addition to decreasing the liability to omit items, it facilitates a comprehensive survey being made of the subject under consideration. To those interested I would suggest that a table similar to the one given be made, showing the total losses—with magnetic leakage—in transformers; the additional losses—due to eddy currents in copper, as well as the increased $C^2 R$ and iron losses, all caused by leakage of flux—being shown."

In the early days of the use of the transformer as it is now known, a closed magnetic circuit was not considered necessary; but now we may safely say that no maker constructs such an instrument without the coils being enveloped by a complete magnetic circuit. The lines of force set up by the coils pass round an iron core, and not through an air space. The design of a transformer may be roughly and crudely described as follows:—It consists of an iron core, upon which are wound two coils of wire, known as the primary and the secondary, and which are insulated one from the other. The core, which should be built up of laminated strips of iron, carries the magnetic lines of force which are set up in the primary coil by the current supplied from a dynamo machine, to the convolutions of the secondary winding, where a current is set up in a direction exactly opposed to that which induces it. Such a transformer may be used for the purpose of receiving current from a machine, and either lowering it in pressure while multiplying its quantity, or *vice versâ*, the exact pressure being determined by the ratio of the transformation. To take a concrete case, we may instance a system of distribution like that from Niagara. The pressure at which current is transmitted from Niagara, after a "throw up" in transformers, is 20,000 volts. Let us suppose that 200 kilowatts are required at some point along the line, and that the pressure required is to be 200 volts. A transformer of $\frac{20{,}000}{200}$, or having a ratio of 100 to 1, must be used. The number of turns on the primary coil would be 100 times greater than those upon the secondary, and the pressure put upon the primary of our transformer will produce a pressure upon the secondary of one hundredth the intensity. Although we have but a few turns of winding of comparatively heavy section on the secondary coil, we must not forget that it must be capable of delivering 200 kilowatts. The primary coil, we will suppose, has 4000 turns upon it, and its 200 kilowatts will be represented by 10 ampères at 20,000 volts, the copper being of sufficient sectional area to carry such a current. Now, as the secondary coil must also carry 200 kilowatts, but at 200 volts pressure, it is evident that we shall be obliged to use copper of such sectional area as will safely and easily carry 1000 ampères, and although only 40 turns are used, it is evident that a very large conductor will be required. Both coils will, however, weigh the same, provided that the current density is the same in each. A perfect transformer, or one as near to such perfection as we may reasonably expect, should possess the following qualifications:—(1) Low magnetising loss. (2) No magnetic leakage. (3) Low copper loss. (4) High-power factor on no load. (5) Iron carefully laminated, selected, and annealed. (6) Thorough ventilation of the iron. (7) Thorough ventilation of the copper. (8) No eddy currents in the copper windings. (9) Low temperature of both iron and coils. (10) Simplicity of construction. (11) Strength in design and construction, so that it may withstand the rough handling to which it will inevitably be subjected. (12) The power to withstand a test pressure between primary and secondary, and between primary and iron, of double that at which the instrument is to be worked.

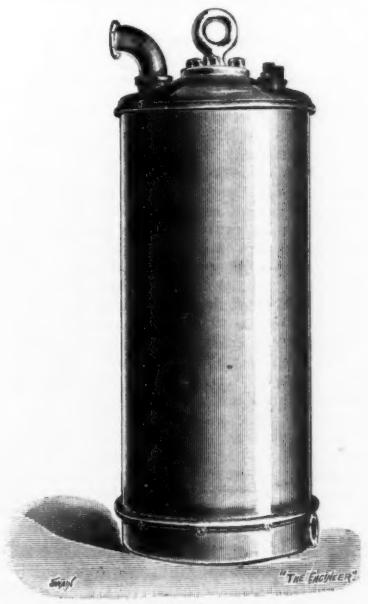


Fig. 1

It is obvious that the loss which occurs during conversion must be dissipated with such rapidity as to prevent the destruction of perishable materials, such as insulation, by the excessive heat, for there are no moving parts in a transformer; and it follows that the second duty of a transformer is to act as a radiator of heat, and it should be constructed so that the waste heat can be rapidly dissipated from every part of the copper and iron circuits in a uniform manner; for it is perhaps more true of a transformer than of any other piece of electrical plant, that its durability is that of its weakest part.

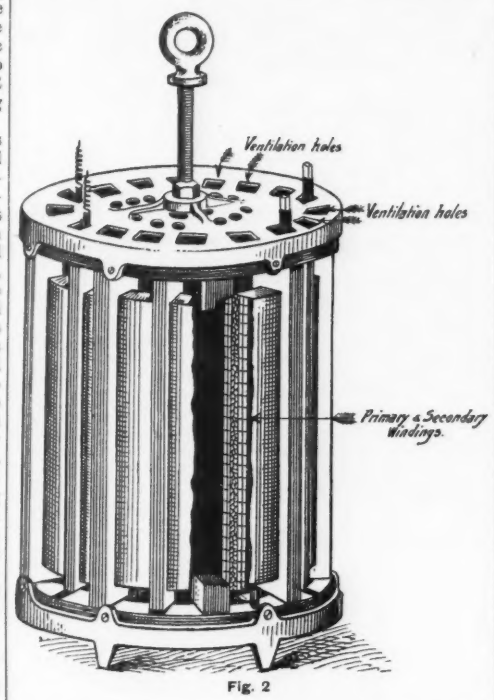


Fig. 2

The two principal losses which occur in the iron core of a transformer are due to (1) hysteresis and (2) eddy currents. These must always be very seriously considered, for, like the poor, they are ever with us, so long as the transformer is on circuit. Hysteresis loss is the work done by the current in the mass of iron magnetising, and if the latter is not of the highest class for its particular purpose the hysteresis losses are greater, for more work has to be done in altering the position of the molecules of which it is formed. It is a little difficult perhaps to make such a point clear, but if we take a permanent magnet, for example, we may safely assume that all its molecules lie in one direction. Now, if we strike such a magnet two or three times with a hammer, the position of the molecules is altered and the magnetisation becomes less. The iron in the core of a transformer is magnetised and demagnetised many thousands of times in a minute—indeed, with every alternation or change in the direction of the current which is passing—and for this reason the molecules are moving at a high rate, with a resulting effect of heating the iron by internal molecular friction. We have recently observed that it has been stated as a perfectly new discovery, that a molecular change takes place in the iron of a transformer after it has been first tested, and that whereas the magnetising loss when the instrument is finished and put to work is not of serious moment, it so greatly and rapidly increases as in many cases to render the transformer most wasteful, and fit only to be scrapped within a few months. But this is not a new discovery, for Mr. G. W. Partridge, the chief assistant engineer of the London Electric Supply Corporation, published the fact as long ago as 1894, and proved by the curves which he gave that transformers in many cases increased their hysteresis losses by as much as 60 per cent. within a few months. Many theories have since been framed to account for the change, and it is now generally agreed that the cause is due to the hardening of the iron, and to the fact that there is a sort of fatigue or reluctance to move, set up in the molecules, which has to be counteracted by a greater application of coercive force. Great improvements have been made by our manufacturers in this particular direction. In 1888 and 1889 transformers were made and in use in large quantities having a loss of 15 per cent. and over. We have by us the figures of a test made upon one of the best transformers turned out in 1887, and of those of a similar test made on a similar transformer, but built ten years later. The 1887 transformer showed a loss of 1000 watts, that of 1897 of 120 watts, and both were of 15 kilowatts capacity.

Transformers, above all things electrical, are worth paying for, as even a good transformer consumes a considerable amount of energy for which there is no return, and even in most of the very best makes the light load appetite increases from 30 to 40 per cent. during the first year or so, on account of the molecular change in the iron. It has been noted that in this particular respect American and continental plant, and even more particularly the former, are the greatest sinners, it being the peculiar characteristic of American practice in transformers, as well as in almost every other design, to reduce material to an irreducible minimum. We have long ago learned that it is far cheaper in the long run to construct more solidly, though the prime cost is increased considerably. The eddy currents set up in the core have yielded very greatly to superior and advancing knowledge, and in modern transformers such a cause of loss has been much reduced by more careful lamination of the iron. Considerable losses still occur from this cause in copper windings, particularly in cases where the sectional area of such windings is large, and in recent practice it has been found preferable to wind several coils of small section in parallel on the secondary rather than to rely upon one large one; but the copper losses are always of less consequence than those which occur in the iron, for they only exist when the transformer is loaded up, and they can be to some extent neutralised by running "high" on top load. The loss which is due to magnetic leakage is quite another thing, and is not, we think, always properly understood. It is really due to the fact that the magnetic lines of force set up in the primary do not *all* pass through the secondary, such a result causing an additional "drop" on full load. For this reason it is advisable when getting out a specification that the "drop" should be differentiated, and the engineer should lay down simply what he will accept as hysteresis loss, defining the "drop" on full load to be so much per cent., and to be divided into so much for copper loss, and so much for magnetic leakage. In some types of transformers the latter loss is very high, more particularly where a large air space, or a large amount of insulation, is placed between the coils. In our opinion, such a source of loss ought to be negligible, for it could not exist in a well-designed transformer.

We illustrate the general design of the three types of modern transformer which are most in favour with our supply companies' engineers:—Figs. 1, 2, and 3, shows the Berry transformer in its simplest form; Fig. 4 the principle of the Mordey and Westinghouse transformer; Fig. 5 the general lines of the Kapp type. It will be seen that the Fig. 1 type is as near to the ideal as possible from the point of view of a radiator, having large and uniform cooling surfaces both for copper and iron, and both on the inside and the outside. The second type, Fig. 4, has a fairly large cooling surface for the iron circuit, but is at a disadvantage in that the copper circuit for the greater portion of its length is entirely enveloped by iron, which is always at a temperature considerably in excess of that of the surrounding air, and therefore incapable of taking up rapidly the heat which is generated in the copper circuits. The Fig. 5 type is most convenient for repairs, and possesses large cooling surfaces for the copper circuits, which have, however, to dissipate the greater part of the heat generated in the iron circuit besides getting rid of their own waste energy. The chief difficulty in design, more especially for large sizes, must be ventilation, for all the parts of the transformer. Most manufacturers have the whole of the iron jammed up as tightly as possible, with absolutely no room for getting rid of the heat, so that in sizes over 10 kilowatts—and soon a 50-kilowatt transformer will be considered very small—the iron gets far too hot; while again some makers, though securing ample ventilation for the iron, neglect the copper, with the result of unduly increasing the drop at full load. There are, however, other difficulties in design to be overcome, and we may suggest that there is still much room for improvement in the mechanical construction of the apparatus; for it is obviously of the first importance that the coils do not move in any way when the thing is being handled with that gentle care which is the characteristic of the British workman.

Fig. 3

Many a fault has been thus developed, and many a breakdown may be traced to handling; for in the past the design of transformers has been conspicuous on account of the absence of mechanical consideration. Improved mechanical design is now to be found in all electrical machines, for our electrical engineers are emerging from the study into the workshop, and they begin to realise that there are three essential qualities which every transformer must possess, viz., (1) it must never fail; (2) it must work efficiently; (3) it must be convenient to handle, and occupy small floor space.

The central station engineer has experienced so many grave troubles with his transforming plant in the past, and so deeply rooted has his idea become that trans-

formers must break down after a short life, that he is still a little sceptical as to the improvements which we may assure him are being made in construction, and we fear he is still on the look out for the manufacturer who recites how his goods are easily repaired. Let him believe that there are now several builders of transformers, and we would advise him to leave himself in the hands of those approved specialists who make their design and construction a careful study.

The testing of efficiencies is by no means an easy matter unless accurate instruments, and trustworthy operators of these same instruments, are at the disposal of the engineer. Most of the alternating-current companies have their own staff of trained and competent experts to do such work, and have very largely their own methods, concerning which they are more or less jealous; but it may be taken as certain that they are in a position thoroughly to examine every detail of a transformer with a critical knowledge of its design and construction. As an example, we give a typical efficiency curve taken from the tests of a 30-kilowatt 1897 Berry transformer with a ratio of 2400 volts to 200 or 100 volts, from which it will be seen that extremely high efficiencies can be relied upon. Fault may only be found with the light loads, but at the same time it would appear to be wrong to advocate, as has lately been done in America, the use of transformers with a heavy copper loss at full load, if only for the reason that the whole output of the generators is required for use in the consumers' lamps or motors, and even one or two per cent. can ill be spared for additional loss in the transformers. The fact that they form the link connecting the generating station with the consuming apparatus, and are usually at some distance

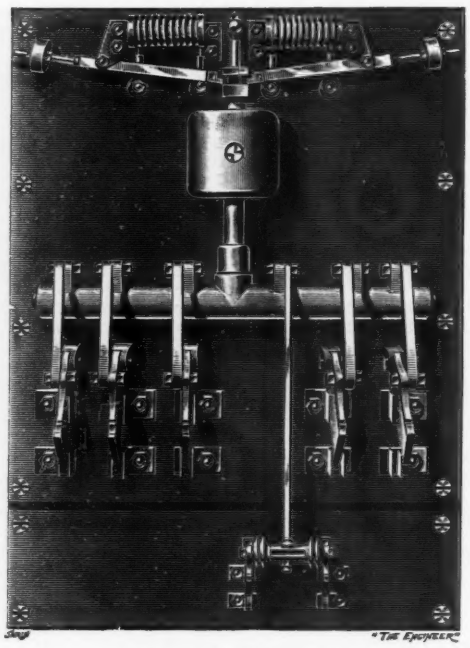


Fig. C—WALTON SWITCH

from help, renders them worthy of the greatest care that can be bestowed upon their design and construction. They ought to have no place in a central station, since modern science begins to see no practical limit to the pressure at which alternators can be run. It is true that at Niagara on "the other side," and at the new station of the Metropolitan on this, comparatively low-tension machines will deliver current straight into transformers; but at Deptford, where the engineers have over seven years' experience of extra high tension, we hear they are about to discontinue the use of the smaller machines; replacing them by larger ones of 10,000 to 11,000 volts, and are sending all the 2400 to 10,000-volt transformers up to the London sub-stations for the reception of the 10,000-volt current, and its conversion to about a quarter of that pressure for distribution. There is no intermediate point between right and wrong with a transformer when it is breaking down, and for this reason it must be well made, for it herein differs very materially from alternators and dynamos, which may still give a supply although partially disabled, and which are usually backed up by a duplicate ready to start at a moment's notice.

Some years ago the mortality in the high-tension and extra high-tension transformers was very much higher than it is to-day, and the reduction in the rate of such mortality is due to the better methods which have been adopted in use, as well as to the improvements which have undoubtedly taken place in design and construction. We may instance one cause of the improvement in use, as being largely due to the better switches and apparatus which are now generally installed. It was discovered some years ago, for example, that in switching "on" the secondary coil should be put into circuit, especially where extra high-tension current was being used, as the iron was thus magnetised synchronously with the machine, and when the primary circuit was closed a rush of current, due to the iron being left magnetised the wrong way, was avoided. In taking a transformer "out," by means of a switch with a slightly longer leg on the secondary side, the low-tension circuit is broken last, and much arcing is so saved. As the

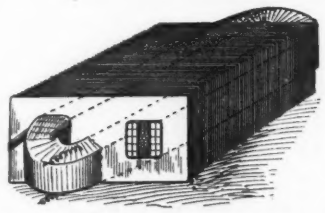


Fig. 4—TYPE OF BRUSH & WESTINGHOUSE TRANSFORMER

extension of independent sub-stations upon an alternating-current system becomes more general, it is essential that the putting in and out of commission of transformers shall be effected automatically, and with promptitude and safety. In neighbourhoods where consumers are separated by some distances it is necessary that a transformer be installed in each house, and as such transformer must be large enough for the full demand of the consumer, and be always available for his service, it is obvious that the cost of magnetising, which naturally falls upon the supply company, is out of all proportion to the revenue earned; indeed, in many cases—as, for example, the houses of some of the great leaders of society, wherein thousands of lights are installed to be

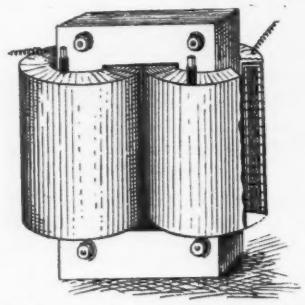
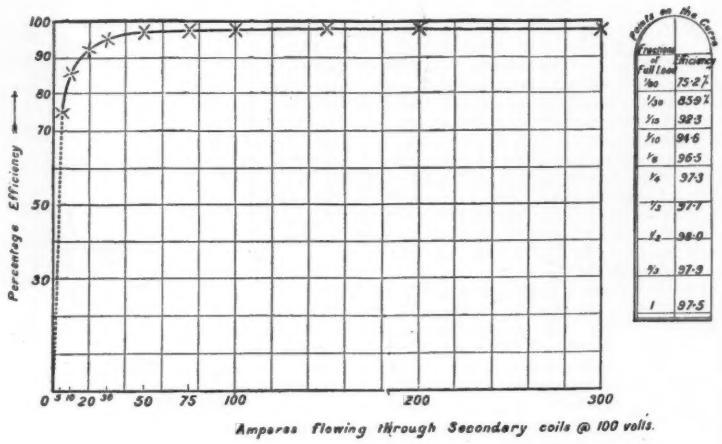


Fig. 5—TYPE OF JOHNSON & PHILLIPPS TRANSFORMER

used only during the few months of the London season, and even then only on the occasion of special and necessarily rare entertainments—the cost of magnetising far outweighs the revenue received, and the supply company actually pays for the honour of having such houses attached to its system. Where several houses are near together, and which are being lighted by the same company, it has been found well to place the transformer or transformers in one of such houses, lighting the others on what may be called a little low-tension system. But as consumers multiply, and the lighting becomes more dense, small transforming sub-stations are being erected in many parts of London, in which plant necessary for the demand around it is placed. A large number of such stations is connected with the mains of the City of London, and generally situated within the precincts of the disused City graveyards. These sub-stations are unattended, save by a staff of perambulatory automatons in the shape of assistants, whose duty it is



to reduce or increase the power of the transformers at work at any time in proportion to the demand of the moment, or the probable demand of the immediate future. The application of alternating current at high tension to the entire lighting of London, both within and without the walls, must be the "fittest," and it will survive when all the low-tension companies have ceased from troubling and their engine-rooms are at rest. The crushing cost of the maintenance of high-tension alternating current supply has been in the main caused by the great magnetising losses in transformers. This has been reduced, as we have indicated, by the grouping of consumers. It will be enormously lessened by the independent sub-station extension, and as such sub-stations are within the control of the supply company, the highest economy can be effected in the measuring out of the plant to the varying conditions of the load. Few engineers have had more experience of the working of alternate-current supply than Mr. A. H. Walton, the well-known and popular engineer to the Metropolitan Electric Supply Company, and none can realise more seriously than he does the importance of economy in the use of transformers, as the practice of economy must bring the costs of the production of a unit of current by high tension even lower than it is by low tension, and thus take the last foothold from under the feet of the continuous-current companies. Several engineers have tried their hands and heads in the design of an automatic switch which should be capable of throwing in or out of commission plant required to be so dealt with; but most of the results have been unsatisfactory. Mr. Walton, with perfect knowledge of what is wanted, has just brought out a switch which is not of this order, but is mechanical and practical.

The photographs which we reproduce make the general idea of the switch quite clear. Fig. 6 shows the apparatus open, Fig. 7 shows all six switches closed. The apparatus has, in all, six switches; one double-pole switch for the primary, mounted on an independent marble base; two single-pole switches for short-circuiting the solenoid after the switch is brought into action; and three for

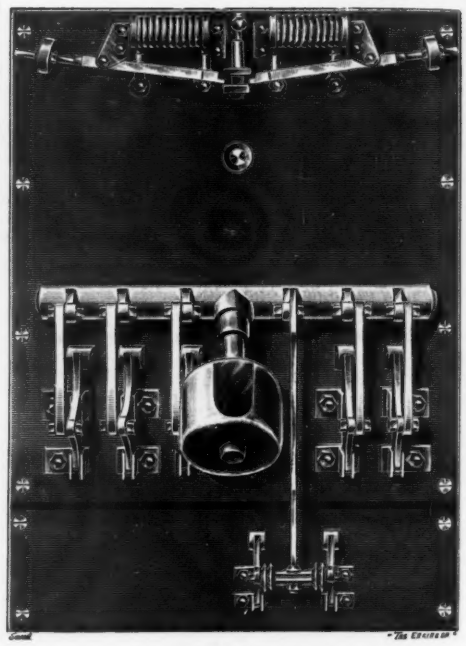


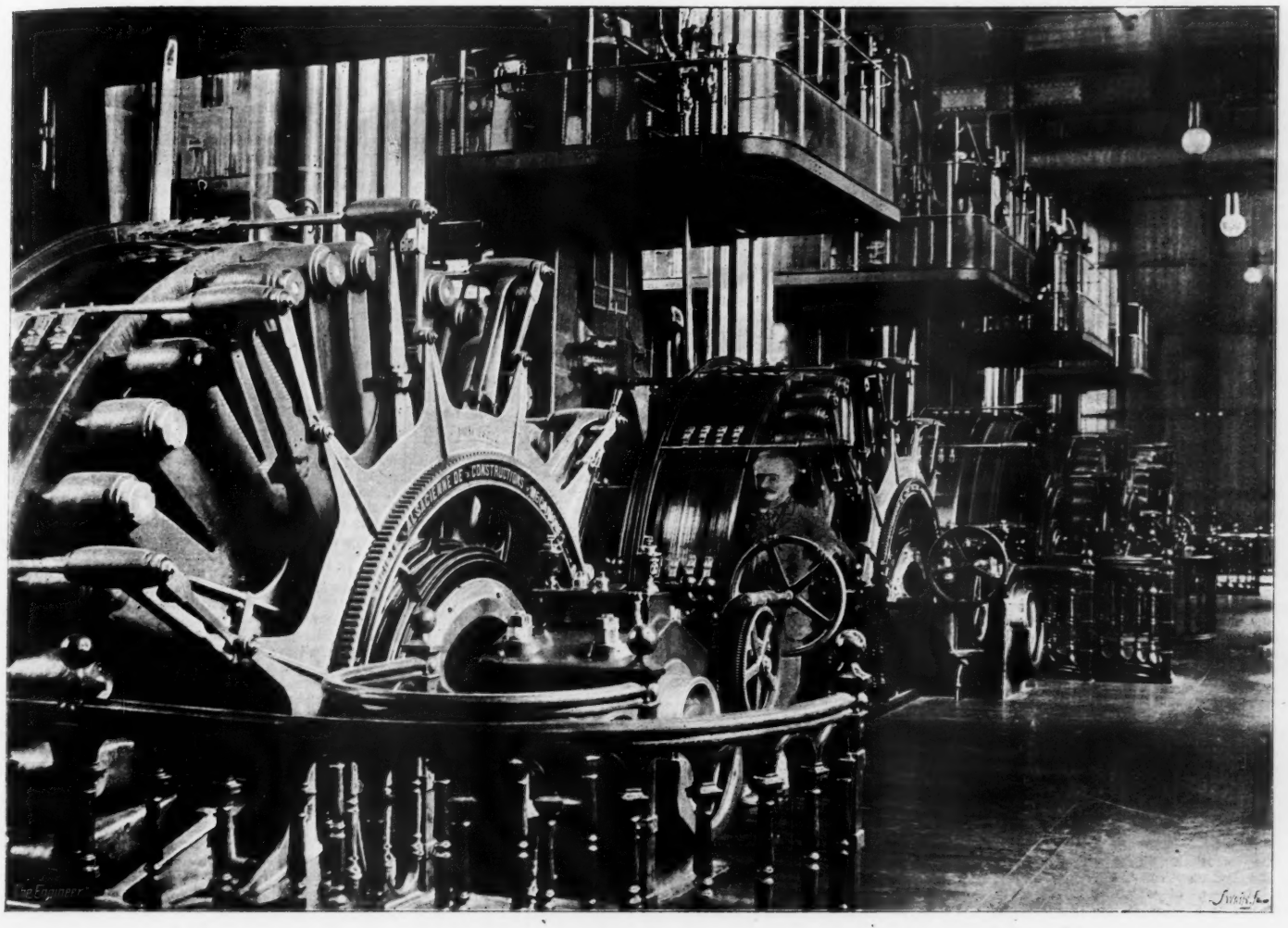
Fig. 7—WALTON SWITCH

connecting the transformer on the low-tension side of a three-wire system. The coils at top, when the switch is open, carry the currents on the two sides of the secondary network. When the current in either exceeds a certain amount it attracts a counterpoised armature, which knocks up a catch and releases the weight, which by falling closes the switches. The armature counterpoise can be locked in any position by two nuts, so as to regulate the sensitiveness of the armature. As the weight falls over it closes the secondary circuit first, thus magnetising the core in phase and preventing any serious rush of current when the primary is closed. The two switches to the right short-circuit the solenoid coils, and the closing of the secondary puts the current through the solenoid coils of the next switch into circuit. The switch contact pieces are carried on insulating bars. The weights are replaced by hand, and the attendant can judge how many transformers to cut out by looking at the ammeter. Should he, however, replace one weight too many, it would immediately fall back automatically.

The practical success of this switch—and we believe that it has withstood the test of time—renders the use of large transformers with slight losses not only desirable, but in the highest degree economical in the sub-stations; and, as we have already said, transformers of 50 to 100 kilowatt size will soon be those to which we shall refer as "small."

We illustrate two forms of Berry transformers designed for transmitting electrical energy in bulk over long distances at extra high voltages; from these photographs some idea may be formed of the growing tendency to adopt large plant for the transmission of energy from the distributing stations of our great companies. The improvements in transformer design and construction since "Moody" and "Sankey," the first two great converters, were built by Ferranti and installed at Deptford, have been continuous and practically mechanical in this country, and they have done more than anything else to further the ever-extending use of alternate currents, and it is this great demand for efficient and safe transforming plant which has enabled the British manufacturer to get so well ahead of his "cousins," and to demonstrate to his customers the fallacy of sending gold abroad, and taking iron and paint—short weight too—in exchange.

CENTRAL GENERATING STATION, QUAI JEMMAPPES, PARIS



PARIS CENTRAL ELECTRIC STATIONS.

THE progress of electric lighting and power schemes—always interesting to engineers—acquires a special significance when observed in an old-world city like Paris. Innovations made their *début* in a different way to what a zealous reader of the papers may observe in America or the Colonies. The introduction of modern improvements in a country of comparatively recent origin, and the introduction of the same improvements into a city of thirteen centuries, where the lamp of Truth oft dwindles before the glare of inherited tradition, are two very different things. Inventions are, for this reason, rarely "rushed" in Paris. The unwillingness of mankind to overturn existing arrangements, however bad they may be, must plead as an excuse for the comparative "slowness" of France compared with her rivals in the van of civilisation.

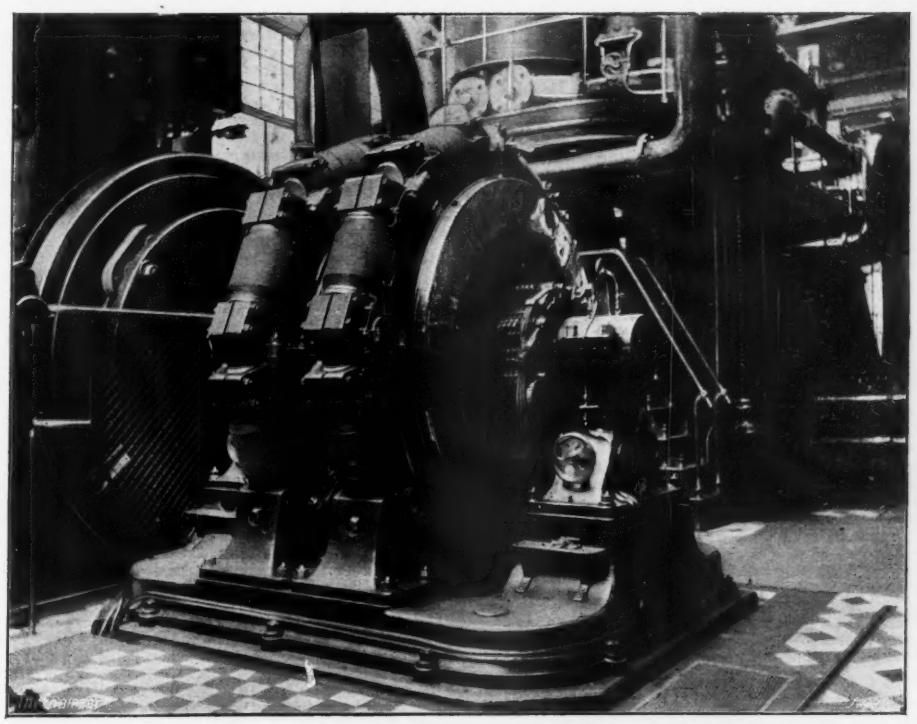
As was to have been expected, the year 1888—that of the great Exhibition—did much to advance the cause of electrical work and power transmission generally. The actual concessions granted to Paris since 1888 by the municipal authorities are six in number. A seventh circuit—on the left bank of the Seine—has lately been sanctioned, and an intricate network of cables, representing in all a million and a-half kilowatts, covers Paris from the slums of the Latin Quarter to far beyond the fortifications. In the western suburbs electrically-propelled tramcars are threatening to displace steam and horse cars together. No especial monopoly in any particular direction seems to have been attempted. The lines belonging to companies of widely different interests and financial standing cross and re-cross in mazy confusion, each particular contract bringing a new addition or extension from the mains into play.

As far as the general problem of power transmission is concerned, perhaps the Compagnie d'Eclairage—Saint Ouen—have proved the most successful pioneers of the now generally adopted long-distance system. The current from the alternating machines in use in one of their further stations, arriving at a tension of some thousands of volts, is converted down to safe limits by rotary transformers, and the moral pointed to by the successful working of the line is, perhaps, sufficient to ensure at some future date all central stations being removed from the precincts of habitable Paris, and transferred to the outskirts.

The system of underground cables is, on the whole, remarkably perfect, supervision taking place at regular intervals along the main circuits. The few accidents reported in the run of the last two years, through contact with gas, short-circuiting, &c., have proved in many ways beneficial, by stimulating the attention of the authorities and promoting greater care in connection with this one special danger of electrical power transmission.

Perhaps the most interesting among the large installations of Paris—both as concerns the magnitude and importance of its electrical jurisdiction and the graceful perfection of its mechanical arrangements—is that belonging to the Société d'Air Comprimé, established 1888 on the Saint Martin Canal. The building itself is an imposing structure. The price of land having, in this quarter of Paris, risen enormously—the latest quotations amounting to 500 francs per square metre—the American device of building vertically instead of horizontally has been adopted, and the highest tower—150 feet above the level of the canal—grants a splendid view over Paris. The company's undertakings have, most of them, been on a large scale. The original source of power lay in two stations—that of the Boulevard Saint Fargeau and the Boulevard Richard Lenoir. Twenty-five accumulator stations were commanded from thence, but the system proved slow and expensive, giving way—in 1893—to the five-wire system of distribution, which has now been definitely adopted. Three stations of accumulators have nevertheless been retained. They are fed by the installations of Saint Fargeau and Richard Lenoir. Rotatory transformers are used, whose secondary circuits are coupled in arc with the feeders.

To return to the station on the Saint Martin Canal. The building is divided into three storeys. On the ground floor are the engines and dynamos, on the first floor the boilers, on the third the coal stores and bunkers. This, to the superficial observer, must seem a strange and unnaturally-inversed method of doing things; but, as we shall presently see, there is method in the society's madness.



EIGHT-POLED EDISON DYNAMO, AVENUE TRUDAINE STATION

The question of weight, in a building where heavy mechanical contrivances are superimposed on two storeys, topping up with a coal supply on the third—is an important one. The five engines at present used in working the dynamos weigh, in the aggregate, something like 350 tons, and the electrical gearing comes to little less. The bulk of this mass reposes on the concrete flooring of the basement. The

engine-room itself—of which we give an illustration—measures 75 metres in length by 14 metres in width—225ft. by 45ft. The engines are of the Corliss vertical type, furnished with condensers and making about 70 revolutions a minute. The horse-power, counted 1200 for each engine, is reckoned 1100 or so at the dynamo axle. On account of the great size of these engines the cylinder bases, round which a steel gallery leads for purposes of inspection, form an intermediate storey, where are placed the manometers, &c. The coupling with the dynamo is, of course, direct, and the weight is equalised by a heavy fly-wheel—31 tons—at the opposite extremity of the shaft. The Société Alsacienne, perhaps the largest mechanical workshops of the Continent, are responsible for both engines and dynamos.

The latter, as will be seen from our illustrations, are sufficiently original in design to command some attention. The armature is wound somewhat after the model of the now venerable Gramme ring—in thirty-nine poles or sections. It revolves on the outside of the electro magnets, which are twelve-poled, and solidly bolted to the metal base. At seventy revolutions the current developed is 1500 ampères, under an electromotive force of 500 volts. This gives a total power of 750 kilowatts. The brushes are of copper, and divided into twelve series. An ingenious arrangement has been devised for regulating their position from headquarters without the use of verbal orders, so exhausting and generally unintelligible in engine-rooms. Each series of brushes is controlled by a lever and screw gearing. A dial on the wall opposite each engine is furnished with lamps of various colours, and the orders are noiselessly "flashed" from the distributing-room in conformance with a settled code.

The boiler-room is on the first floor, 40ft. above the basement. The boilers are of the Belleville type, working at about 180 lb. to the square inch. The quantity of steam supplied is reckoned at 6000 lb. per hour. The grate area of each amounts to 5·25 square metres, the number of boilers actually in use being twenty—four to each engine. The system of coal distribution is ingenious. Electrically-worked lifts raise the combustible from the courtyard to the roof, where it is tipped into funnel-shaped bunkers of iron. From here it falls by its own weight on to the floor of the boiler-room. An iron bridge leads to another wing of the building, where are situated the water tanks and a large filter for the purpose of purifying the water before admitting it to the boilers.

The cables used to conduct the current are of 1000 square millimetres section, and emanate, like the rest of the mechanical contrivances, from the workshops of the Alsatian Company. They are lead covered, laid directly in the earth, without conduits or casing. A complex system of rheostats permits the distribution to be regulated to a nicety. As mentioned above, the large number of accumulator stations once dependent on the Société d'Air Comprimé has been cut down to two or three. The most important of these is the Mauconseil station. The accumulators are 280 in number, divided into four groups, and representing a total of 2200 ampère-hours. 300 ampères is the maximum usually demanded at one time. They are charged either at normal tension or by over-voltage, as time or circumstances require.

The installation of the Continental Edison Company in the Avenue Trudaine is the largest of the four Edison stations, of which the other three are situated respectively at Montmartre, Saint Georges, Palais Royal. Like the Air Comprimé station, it is divided into three storeys, but the arrangement is different. The boilers are underground, the engines and dynamos on the ground floor, the tanks, switches, and filters on the first. The coal supply is managed without difficulty from the street, but the necessity of employing an ash-lift has given birth to some rather clumsy machinery. The boilers—Belleville type—are nine in number, working at a mean pressure of 112 lb. to the square inch, and delivering in the aggregate some 12,000 lb. of steam per hour.

The dynamo and engines are coupled direct, an intermediate fly-wheel, weighing 17 tons, being introduced for regularity's sake. The magnets are eight in number, with eight polar expansions and eight series of brushes. They are arranged in the form of an octagon round the central shaft, forming a sort of tunnel through which currents of cold air play incessantly, assuring ventilation and freedom from heating. There are two commutators, one at each extremity, the current being collected by carbon brushes. The number of revolutions per minute is 132, yielding a current of 1600 ampères at a tension of 130 volts. Four dynamos are now in actual use, although extensions and additions are expected shortly. The engines are of the Bonjour type, resembling the Corliss vertical engine in appearance, and only differing in unimportant details. The lubrication is performed automatically. A 100-gallon tank of oil on the first floor contains the supply, which after passing through the bearings is led to a cotton filter and re-pumped into the reservoir by a diminutive electric motor to be used over again.

Besides the four Bonjour engines, there are two Pilon motors of 1000 horse-power each, coupled direct to two Brown dynamos, capable of delivering 4400 ampères under an E.M.F. of 130 volts. These engines are of the vertical Corliss type. The working speed is about 100 revolutions per minute. The dynamo is placed between the cylinders. One of the most—indeed, *the* most—interesting feature of the Edison station is the *table de distribution*, or switch-room, which is on the first floor. The current produced is transported hither on parallel rails of copper supported by large porcelain insulators. At first sight the apartment resembles nothing so much as a large railway signal-box. The switches are placed in a triple row, the handle of each section being surmounted by an ammeter of simple construction—a revolving sphere of wire working in a copper loop. The rheostats and supplementary resistance boxes are arranged underneath. An automatic device, too, gives notice of the more important changes in tension. Two lamps, a blue and a red, work in connection with a series of volt meters. When over-voltage is the trouble, the red lamp lights of its own accord; when a falling off in E.M.F. declares itself, the blue lamp lights up.

THE EFFECT OF COMPETITION.—Cheaper electricity in New York City will, without doubt, follow the reduction in rates just announced by the United Electric Light and Power Co., of that city. About a year ago the Edison Company introduced a schedule which had as its maximum one cent per 16-candle power lamp per hour. Discounts were given to customers burning their lamps for long periods, and it was claimed that this made the cost in some cases less than half a cent per lamp per hour. Small consumers were required to pay one cent. The schedule just announced by the United Electric Light and Power Co. starts with a maximum of three-quarters of a cent per lamp hour, and grades down, according to the amount of current used and the time lamps are burned, to a minimum of one-third of a cent per lamp per hour.

THE DIRECTION OF PROGRESS IN THE DESIGN OF ELECTRIC LIGHTING PLANT.

ALTHOUGH the general principles underlying the design of electric light machinery are now generally understood, and the various types of plant are beginning to approximate to a few common standards which appear likely to last for a good many years to come, there are still many particulars about which the best engineers differ; for instance, nineteen out of twenty electric light engine builders will agree that the best type of engine for the purpose is a high-speed vertical one coupled direct to the dynamo and provided with a sensitive shaft governor, but in the arrangement of the engine, distribution of steam, &c., there are still great differences of opinion. Then, again, while the great aim of electrical engineers is to make dynamos and alternators which combine simplicity and mechanical strength with high efficiency, the means they use to attain this end are very various. We will take the separate items of the plant one by one, and note the forms which modern experience is giving to them, confining ourselves generally to the types used in this country.

Engines.—The engine used almost universally in England for electric lighting is the high-speed vertical type, either compound or triple-expansion, coupled direct to the dynamo. The Americans are getting rid of their belts and ropes, and coming round to this practice, but on the Continent slow speed horizontal engines are used very largely. The single-acting engine, such as the Willans, will not, in the opinion of several engineers, hold its own against its double-acting rival for many years longer. It was brought out when the high-speed stationary engine was seldom used and but little understood, and it did away with several defects which high-speed engine builders found very difficult to overcome; but now that more experience with this class of engine has been gained, the double-acting engine is rapidly coming to the front, which is not to be wondered at when we consider the performance of a locomotive engine, the piston speed of which at express speed is much greater than that usually used in electric light engines. For instance, an express engine running at a speed of sixty miles per hour, with a 6ft. driving-wheel and 2ft. stroke, will have a piston speed of about 1120ft. per minute, whereas a large Willans engine, driving an alternator direct at 300 revolutions, will not have a greater piston speed than 600ft. per minute. Designers of modern electric light engines, such as Messrs. Bellis, Ferranti, Raworth, and several others, now use double-acting enclosed engines, with forced lubrication, the oil being pumped into all the bearings, &c., under pressure, sometimes 100 lb. per square inch or more, which gets over the difficulty of brasses knocking very satisfactorily. Willans' engines will no doubt be used extensively for many years to come, as they are very efficient at full load and speed, and govern well, but being single-acting they, of course, take up much more space than a double-acting engine of the same power. They are sometimes very noisy at light loads, and they require careful driving and the services of workmen who are used to them for repairs, as the ordinary engine fitter cannot be trusted with them. Yet on the other hand, they are preferred to all other types by several engineers, because they will run for many months without any repairs, examination, or special attention. A good deal appears to depend on the quality of the steam, which will account for the diverse opinions expressed. With the ordinary steam pressures used in central stations there is no gain and often a loss by making these engines triple-expansion, unless they are worked with condensers, and even then the gain hardly compensates for the extra complication. Messrs. Willans and Robinson are now making some of their largest engines compounds. These have three lines of cylinders, with cranks 120 deg. apart. When run condensing these compound engines will be found more suitable for electric light stations than the triple-expansion type. The present tendency is to build much larger engines for electric lighting work. Engines of 1000-H.P. are now fairly common, a few of larger power are running, and several of 2000-H.P. and over are being built. This, of course, adds to the efficiency of the engine, and as large dynamos are more efficient than small, there is a double gain; but this must not be carried too far, as it is better to have two small machines loaded up than to have one large machine loaded up, and another of the same size with only a few ampères on, or two large machines running at only half load.

With regard to engine details, the present tendency is to use only two shaft bearings if possible, so that the weight may be evenly divided between them, the bearings being made spherical to allow of a slight play in the shaft. With alternators of the fly-wheel type, such as the Ferranti, Siemens, Fowler, and one or two others, the practice is to place the high-pressure cylinder on one side of the fly-wheel and the low-pressure on the other side, using overhung cranks and two bearings only. Condensers are not now fitted to each engine, but a common condenser is used for all or several of the engines, according to their size, with a separate engine to work the air and force pumps. The size of fly-wheels has been gradually diminishing year by year, except in the case of fly-wheel alternators, and quite small discs are now employed, as in the Willans engine. It is found that these small fly-wheels are quite suitable for traction as well as lighting work, and they are much safer than the large. There is a tendency to make connecting and piston-rods hollow, and the former are often fitted with spherical brasses at both ends, which allows the rod to set itself in the best position. Bored guides and tunnel slipper blocks with large bearing surfaces are general, and double piston-rods are being tried on account of the simple crosshead of which they permit, but this advantage will probably not compensate for the trouble of getting the two rods perfectly parallel, packing two glands, &c.

With regard to governors our engineers are coming back to the throttle valve type with shaft governors; this is probably owing to the success of the Willans governor, which has proved itself very suitable for electric lighting work, as it is possible to run six or eight large alternators in parallel with very little attention when coupled direct to these engines if the governors are looked after and kept clean.

An engine which will perhaps be used somewhat largely for electric lighting in the near future is the steam turbine, by which we mean more particularly the Parsons steam turbine, as although there are others on the market Mr. Parsons was the first to make this type of motor a success from a practical point of view, and now that his patent has been extended for another five years we may expect improvements which will place the steam turbine on a level, in certain respects, with the best electric light engines of the reciprocating type. The great advantage of the turbine is its absence of vibration, which renders it very suitable for towns, hotels, &c., where vibration is a nuisance. The high speed is a disadvantage, but Mr. Parsons has got over this by designing dynamos and alternators to suit his turbine, and these combined sets are running in a dozen or more central stations, and are spoken of highly by some station engineers. Another disadvantage of these turbines is that they cannot be run in parallel owing to the high speed, but this defect will probably be remedied in time.

Gas engines are now used very largely for electric lighting, principally for private isolated installations for lighting such places as factories, shops, hotels, &c., as they are more economical than small steam engines and boilers, and give far less trouble. The gas engine has been brought to such a state of perfection that it will drive a dynamo almost as steadily as a good steam engine, and a large gas engine driven by water-gas is a very economical prime mover, although it cannot compete as yet with large compound or triple-expansion steam engines. Gas engines have been tried in central stations but without much success, although the Midland Railway Company has an installation driven by these engines at Leicester for lighting the goods warehouse, station, sidings, &c., which is said to be very satisfactory.

Boilers.—The Lancashire boiler, which was put down in nearly every one of the older central stations, is still put down in the majority of new stations; but water-tube boilers have been, and are now being, extensively used, especially the Babcock and Wilcox boiler, which, after many experiments, has been brought into a form very suitable for electric lighting work. The advantages of water-tube boilers are the quickness with which steam can be raised in them, owing to the large surface exposed to the flame and hot gases, and rapid circulation of the water; comparative freedom from serious explosions or breakdowns; the ease with which repairs can be effected; and the greater power which can be got into the same space when compared with Lancashire boilers. Water-tube boilers have their disadvantages, however, the chief of which is the cost of cleaning and repairs, which is rather heavy, especially the cleaning, as these boilers have from 200 to 400 or more tubes, according to size, and each tube has to be scraped and then brushed out, and double the number of caps cleaned and screwed down over holes in the headers opposite the ends of the tubes, each cap having a faced joint. The soot has to be swept off the outside of the tubes, and the steam and water drums cleaned out, so that the operation of cleaning a large boiler of this type takes a week at least. The repairs consist principally in renewals of split or buckled tubes, and bolts or caps for the ends of the tubes; and these renewals cost a good deal in the course of a year if the boiler is worked fairly hard, whereas a Lancashire boiler will work for years and require practically no repairs.

Messrs. Babcock and Wilcox are now fitting most of their new boilers with superheaters, which consist of a nest of small tubes placed over the water tubes at the back of the boiler; the steam passes through these tubes before it reaches the steam pipe, thus greatly reducing the quantity of water which is usually found in the long steam mains of a central station, and delivering the steam to the engines at a higher pressure than would otherwise be the case. The economic boiler made by Messrs. Davey, Paxman, and Co., Limited, Colchester, is rapidly growing in favour. In one or two new stations where space is available plants are being put down for purifying the feed-water before it enters the boilers, and this practice will no doubt be largely followed in the future where the cost of land for the settling tanks is not prohibitive, as this is really the only way to prevent scale forming in the boilers, and it will be found to pay in the long run, as the life of boilers, valves, and fittings, is much lengthened by using pure feed-water, and the cost of cleaning reduced to about one-half. Water-tube boilers especially should be fed with as pure water as possible, if their efficiency is to be kept up.

Mechanical stokers are now used with many large batteries of boilers for electric lighting, as they undoubtedly save their cost in labour in a few years where more than six or eight boilers are used, and they have other advantages, the chief one, perhaps, being the fact that they prevent smoke in a great degree, as the coal is burnt at one uniform rate and the furnace doors do not require to be opened, thus avoiding rushes of cold air into the furnace. Another advantage is that cheap small coal may be used, which can be made to give very satisfactory results if properly worked in a good mechanical stoker; and another point in their favour is that only one skilled fireman is required to attend to a large battery of boilers, as he will adjust the feeds on the stokers, dampers, &c., while the men under him are merely required to clean the fires, and may therefore be unskilled labourers. There are several mechanical stokers on the market, the Vicars stoker being used most largely at the present time; but there is a good deal of room for improvement still in all stokers in the way of strengthening and simplifying the parts. The stoker gear is driven by a motor or small engine, whichever is most convenient, and a spare one is provided in case of accident. It is a mistake to have all the boilers fitted with mechanical stokers; enough boilers to take the ordinary day load in summer should be left for hand firing, in order that the mechanical stokers may be stopped entirely for several hours if necessary, and hand-fired boilers are useful for burning rubbish, &c., and for tests on coal.

With mechanical stokers the coal is either delivered into a store on a level with the boiler-house floor, taken from thence by a conveyor along the fronts of the boilers, and dropped down short shoots into the hoppers, or else it is lifted into an overhead store and dropped down long shoots into the hoppers. The latter plan is the more expensive of the two, but should be used for large batteries of boilers, as the risk of breakdown is less; the former arrangement is very suitable for a small number of boilers, six or eight, or less. For hand firing the coal is either put into a bunker running the length of the boiler-house, and communicating with the stokehold by sliding iron doors, through which the firemen can rake the coal to the fronts of the boilers, or else it is delivered into a store at one end of the boiler-house and taken to the fronts of the boilers in tip wagons along a small railway, the former arrangement being the best for a small number of boilers and the latter for large batteries. The great defect of all mechanical stokers is, however, that they will not permit the boilers to be forced in order to deal with the peak of the load; for that no adequate substitute for hand firing has yet been found. The success of mechanical stoking depends on ample boiler power, which is by no means always in existence.

Marine boilers are being put down in several new central stations, and are likely to supersede Lancashire boilers where water-tube boilers are not used, as they are quicker steam-raisers, and have other advantages; but mechanical stoking becomes difficult on marine boilers with more than two furnaces. A good arrangement of boiler plant would be to have three-quarters of the power supplied by water-tube

boilers fitted with mechanical stokers and superheaters, and the remaining quarter supplied by hand-fired Lancashire or marine boilers fitted with superheaters. These boilers would take the light day load, and the water-tube boilers could be put on as the load rose in the afternoon. An economiser should be placed in the main flue, and an induced draught fan is very useful with a large battery of boilers, unless the chimney stack is of exceptional height. A feed-water heater should also be provided to utilise the exhaust steam from the non-condensing engines. Automatic safety devices, such as low-water alarms and the like, are often fitted to boilers for central stations; but this is a mistake, as they cannot be depended upon for long, and get the firemen into careless habits.

Steam mains.—These are now generally made of welded steel with large bends for expansion instead of sliding joints; the ring main arrangement is generally adopted for small stations, but for large ones the mains are made as short as possible on account of the great loss by condensation.

Generators.—In designing electrical machinery engineers now pay as much attention to the possibility of breakdown as to efficiency, with the result that modern machines are strong mechanical jobs. The paper, string, and shellac insulation of the older machines is replaced wherever possible by vulcanite, sulphur, and other stronger insulating materials; this is very noticeable in the later Ferranti machines. The question of iron *versus* no iron in the armatures of alternators is not settled yet, and good machines are made of each type, as both have points to recommend them. The present tendency is to increase the size of alternators, and machines with an output of up to 2000 kilowatts are being used in England, and even larger on the Continent; but this practice, as we have said before, can be carried too far, the personal gratification of the builder or designer of these machines entering more into the question than suitability. These large alternators are now generally made of the fly-wheel type, with only two main bearings, and the engines, whether vertical or horizontal, are placed one on either side of the fly-wheel, which is sometimes the armature and sometimes the field magnet. The large size of the fly-wheel permits of a high voltage being obtained with a moderate speed, 200 revolutions per minute being about the maximum for this type; while some of the latest which have been put down—those at Halifax—run at a speed of only 112 revolutions per minute. These machines are driven by horizontal engines, and the field magnets revolve, being built upon the rim of the fly-wheel. It is very probable that in new stations, where a motor load is expected, three-phase alternators will be used entirely, as these machines when run at a periodicity of fifty or sixty, are equally useful for lighting or power purposes, whereas a thoroughly satisfactory single-phase alternate current motor does not exist at present. Three-phase alternators driven by slow-speed horizontal engines are used very largely on the Continent, and it is likely that we shall follow continental practice in the use of inductor alternators, as these machines are very strong, owing to the fact that the armature and field magnets are stationary, the only revolving part being the iron pole pieces. Several English firms are now making these machines.

With regard to the paralleling of alternators, which is now general, this depends on the engine more than the alternator, a sensitive governor and even turning moment on the engine being the chief requirements; but at the same time it is not advisable to run different types of alternators in parallel if it can be avoided, nor to run machines together which differ very much in size.

With regard to continuous current dynamos, the same remarks as to strength and simplicity of construction will apply as to alternators, and modern dynamos will stand a tremendous lot of hard work. Two-pole machines are used almost exclusively for the small and medium sizes, and often for large sizes, the armatures being generally of the drum type, slot wound, and provided with commutators of large diameter. The beds are made very massive, and the oiling arrangements are automatic, consisting of rings or chains riding loosely on the shaft, and dipping into an oil bath under the bearing. Large modern dynamos for lighting are almost exclusively shunt-wound machines, the output being regulated by means of a rheostat placed in the shunt. They are coupled direct to the engine, being placed on an extension of the engine bed-plate.

Now that it is possible to obtain small incandescent lamps which will stand a pressure of 200 volts or more satisfactorily, continuous-current plant is being put down in many places where alternate-current machinery would have been used two or three years ago; in fact, the latest practice in lighting towns which are fairly compact is to use direct current at a pressure of 400 or 500 volts, raising or lowering this pressure as required at different parts of the system by means of motor generators or boosters. This system has many good points to recommend it. The dynamos are easier to run than alternators, and less likely to break down; batteries can be used, and direct current is far preferable to alternating for motors. The only disadvantage is the greater cost of mains, but for small and medium areas this extra cost is more than made up by the advantages of direct current. Continuous-current closed coil dynamos are now used extensively for arc lighting, as these machines are made to stand a pressure of up to 2000 volts; the old open-coil machines, such as the Brush and Thomson-Houston, are very seldom put down in new English stations, although by far the greater part of the arc lighting in America is done by this type of machine.

In alternate-current stations Ferranti rectifiers are being used a good deal for arc lighting, and although very satisfactory, should be only looked upon as a stop-gap until a really serviceable alternate current arc lamp is produced. The small dynamos for supplying exciting current to alternators are still sometimes driven direct from the alternator shaft, but separate machines are now generally used for this purpose, each driven by its own engine; several of these sets may be connected to a common pair of omnibus bars, whence the current is taken to the fields of the alternators. This system has many advantages over the other, it is much easier to synchronise and run alternators in parallel when excited by separate exciters, as the voltage does not vary, whereas, when an alternator drives its own exciter, the voltage of that exciter, and consequently the voltage of the big machine, varies with the speed; so that just at the time when a heavy exciting current is needed, owing to low speed of the alternator, due to overload or shortness of steam, the exciter is not able to furnish it. To get over this, exciters which are driven from the alternator are generally made a good deal larger than they need be, which is not economical.

Switch gear.—The tendency is to concentrate all the switches and instruments on one board, but keeping the high and low tension separate, this enables the switchboard attendant to see everything that goes on, and prevents confusion. The switchboard is placed at one end of the station, if a small one, and in the centre if a long one, raised several feet above the engine-room floor, so that the attendant can see all the engines, &c., and guarded by railings. It is usual to make the board in panels, each panel being numbered and containing the switch, fuse, and instruments of one machine; this is a simple arrangement, and permits of extension if necessary. Modern switchboards have little or no wood about them, slate being the favourite material, mounted on iron frames, or placed directly against the wall. With actual switches the tendency is towards simplicity and ample conducting surface, especially at the points of contact. The spark at breaking contact is reduced by breaking on carbon blocks, or put out by breaking in oil or water. For high tension work Ferranti switches are largely used, and found very satisfactory. These are single-pole switches, and break in oil, the only objection to them being that they are rather complicated, and require to be taken to pieces and cleaned occasionally. For synchronising alternators several systems are in vogue; some engineers switch the incoming machine on to the bus bars through a resistance, others through a fuse which blows with a certain back current, while others use an automatic cutout for this purpose.

With regard to switchboard instruments, electrostatic voltmeters are most generally used for high-tension currents, and hot wire instruments for low tension, gravity ammeters being used for both. All instruments are made, if possible, with large heavily-figured open scales and broad pointers, so that they can be read from a distance, and the attendant can easily see if anything is wrong. Recording instruments are in great favour, such as recording voltmeters, ammeters, and wattmeters. The latter are used to check the output of the station against the output by consumers' meters and give an idea of the loss in mains, transformers, &c.; this loss can therefore be watched and steps taken to stop its increase. Many different types of fuses are used in electric lighting work, but a really trustworthy one has yet to be invented; they are looked upon as necessary evils at present, and but little reliance is placed on them, the tendency being to use as few as possible, although some engineers say that they should be placed everywhere.

General remarks.—It will be seen from all this that the general tendency in the design of electric light machinery at the present day is towards simplicity and strength of construction. All weak and superfluous parts are done away with if possible, which is owing to the advent of the mechanical engineer on the field of electrical work, as the men who filled it before were mostly scientists or pure electricians, and although their designs were admirable, and the honour of having brought electric lighting to a practical basis belongs to them, they did not understand machinery well enough to build dynamos which would stand the rough wear and tear of a central station for long. All kinds of automatic devices have been tried in connection with electric light machinery, but without much success, the general idea being that they cannot be depended upon for long, and that it is better to employ intelligent men for the work. Attention is now being directed to the auxiliary machinery of central stations in order to improve the efficiency of this plant; boiler feed pumps, for instance, are very wasteful of steam, and larger and more economical pumps will be put down. Motors are being used to drive auxiliary plant, as they are more economical than small steam engines. In some of these conclusions we may have been mistaken, but we believe that the directions indicated are those in which progress will occur, being those taken by many of the foremost men in this work.

THE ISLE OF MAN ELECTRIC RAILWAYS.

THE Isle of Man holds a leading position in the adoption of electric traction, and next season it will possess perhaps the most extensive, and at the same time the most completely equipped system of electric railway in the kingdom. For several years past ready access to the most picturesque parts of the island, including the summit of the highest of the Manx mountains, has been provided, by means of the electric railway, and during the past year further important extensions have been pushed forward, which it is intended to complete by the opening of the ensuing summer season, when there will be in operation electric railways measuring about fifty miles, single rail. At present about forty-five miles single rail are open for traffic, and during a recent visit to the Isle of Man our representative, in company with Mr. J. Aldworth, the general manager, and Mr. Shaw, the electrical engineer of the Isle of Man Tramways and Electric Power Company, was afforded an opportunity for a preliminary inspection of the additional lines that have been opened, which will bring Douglas into direct connection with Ramsay and introduce a very considerable improvement upon the present means of communication between these two important centres of the island. The electric motive power which has been provided for working the line is equal to about 1590-horse power, in addition to which there are three accumulator stations where sufficient power can be stored to provide for any emergency or to supplement the generating stations to meet exceptionally heavy traffic during the height of the season.

There are four generating stations along the line, one at Douglas, with three engines, each of 90-horse power; one at Laxey, with two engines, each of 90-horse power, and one engine of 180-horse power; one at Snaefell, with five engines each of 120-horse power, and a fourth at Ballaglass, with two engines each of 180-horse power. The accumulator stations are distributed at Groudle, where there is a battery capable of giving 140 ampères for four and a-half hours; another at Snaefell, capable of giving 140 ampères for four and a-half hours; and a third at Ballaglass, capable of giving 140 ampères for six hours. In the working of the traffic various alterations and improvements have been introduced during the past season. Previously the power was taken from the overhead wires by means of bar collectors, but these have now been replaced by the trolley system, which entails less wear and tear on the overhead wires. Another improvement which it may be interesting to notice is one that came under the observation of Mr. Aldworth, the manager, during an inspection of various electric traction systems on the Continent. This consists in a very simple arrangement for suspending the line insulators free from the pole arms which carry the electric cables. The general system adopted in this country is to attach the insulators to the pole arms, but Mr. Aldworth has introduced a sort of spring suspension for all the line insulators, which are hung immediately underneath the arms on a cross wire, which can be drawn tight by a turn buckle, which also enables any slack to be easily taken up when necessary. The advantage of this system is that it avoids any shock to the insulator from the trolley collectors, which, when the insulators are rigidly attached to the pole arms, are not infrequently subjected to damage. The wire suspension gives the insulator a certain freedom of movement, which as the trolley collector passes underneath it prevents any violent knock, whilst it also enables the trolley to be driven more easily between the poles. When the whole of the line is completed early next season we may be in a position to give a more detailed description of its general construction and arrangement, with one or two illustrations of the generating and accumulator stations.

THE USE OF ELECTRICITY IN ENGINEERING WORKS.

THE development of electricity as a motive power for engineering works is making considerable progress in the Manchester district. At the works of Messrs. Joseph Adamson and Co., of Hyde, electricity as a motive power is being applied on an extensive scale, the various departments at the present time undergoing considerable alterations and enlargements, which, when completed, will be specially interesting. A few particulars of what has already been done by the firm in adopting electricity as a motive power are well worth noting. The power-generating station, which is close to the boiler-house, contains hydraulic pumping engines, air compressors, and the electric generators, and until quite recently the whole of the power required in the works was developed in this house. Owing, however, to the extensive alterations now being introduced, and the putting down of additional machinery, the electric power plant has become too small, and is shortly to be increased. In this connection it may be interesting to mention that while no appreciable saving in coal followed the installation of the electric power plant about four years ago, owing to the continued increase of machinery, the difference is very marked now that the firm has had to revert partially to the old-fashioned way of driving, and they are now quite sure that electric power in their shops, besides other advantages, means a saving in coal. Near the boiler-house and power station, Messrs. Adamson have just erected a large new boiler smithy into which they are gradually removing from the old one, and they are making important improvements in the arrangements of the plant.

One noticeable improvement is in their special machine for flanging flues, which is being re-started with an electric motor directly coupled to it in the expectation that this will enable the work to be done more rapidly than when the machine was strap-driven. This, at any rate, has so far been the experience of the firm whenever they have applied electric motors directly to strap-driven machines, there being no slip or breakage of belts to interfere with the progress of the work. At the same time a hydraulic crane has been installed to lift the rings from the fire to the machine, while the fan supplying the fire will be driven by a separate motor, as it was before the removal. The boiler shop proper is well supplied with electric three-motor overhead cranes, as might be expected when it is remembered that Messrs. J. Adamson and Co. were amongst the first to introduce three-motor cranes in this district, after having seen them work satisfactorily in the States in 1893. Several of the machines in the works are driven by individual motors, especially the larger ones, whilst the firm has also motors driving lengths of shafting where the machines are small and close together, or where opportunity has not yet arisen to couple individual motors to some of them. The old boiler smithy previously mentioned is at present under reconstruction, and, together with an adjoining shop, will be devoted specially to the making of electric cranes, of which the firm has already turned out a considerable number, and has nearly a score at present on order.

It may be added that at a number of other important engineering works throughout the Manchester district electrical driving power is being introduced on a more or less extensive scale, and at the large locomotive works of Messrs. Beyer, Peacock and Co., considerable plant has recently been put down, for adapting electrical driving to various portions of their shops.

BLACKBURN TRAMWAYS.

THE Blackburn Corporation, whose consulting engineers are Messrs. Lacey, Clirehugh, and Sillar, has recently been installing electric tramways, and the opening of the lines for traffic may be expected at the end of this month or the beginning of December.

There are in all some three miles of track, of which about one-sixth is double, and the trams are to be worked on the overhead trolley system, the return being through the rails, which are specially bonded.

There are two trolley lines, one for the going and one for the returning trams. These lines are for the most part carried on side posts, but in a few places and at the turn-outs centre posts have been used.

The electrical-generating machinery—which, together with the motors for the cars and the other electrical gear, has been supplied by Messrs. Siemens Bros. and Co.—is contained in a wing built out from the Corporation's electric lighting station. The plant consists of two 120-kilowatt bipolar compound-wound dynamos, which have double-wound armatures, and two commutators, with switch gear to put the two parts of the armature in series to give 500 to 530 volts for traction purposes, or in parallel to give 250 volts for lighting. Each of these dynamos is direct coupled to a Belliss E /C10 engine, and they run at 380 revolutions per minute. Each car will be provided with two series-wound motors and Siemens series parallel switch gear, so that on starting the motors may be in series, and when sufficient speed is attained they may be put in parallel.

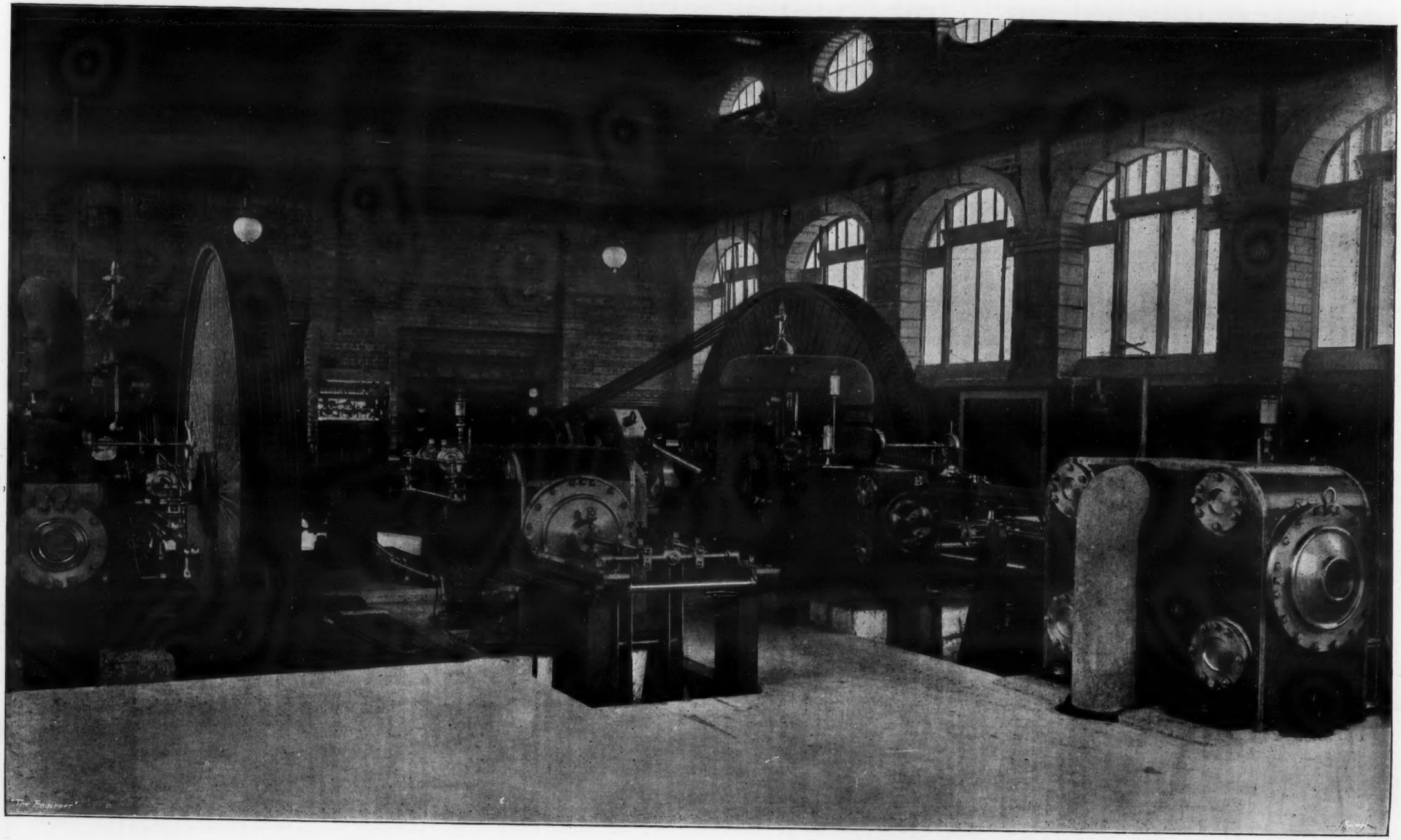
The generators will, in addition to driving the trams, be used for lighting the town by means of arcs round the Town Hall, and there will in also be an incandescent lamp on each of the side trolley wire posts and two lamps on the centre posts.

TUNNEL VENTILATION.—The ventilation of the Hoosac Tunnel is proposed by means of a centrifugal fan mounted at the top of the centre shaft and operated by electric power from the North Adams, Mass., Electric Co. It is stated that contracts for the work have already been let.

THE LINOTYPE COMPANY'S WORKS, BROADHEATH, NEAR MANCHESTER—THE ENGINE HOUSE

MR. JOHN PLACE, M. INST. M.E., CHIEF ENGINEER

(*For description see page* x.)



THE LINOTYPE COMPANY'S WORKS, BROADHEATH, NEAR MANCHESTER

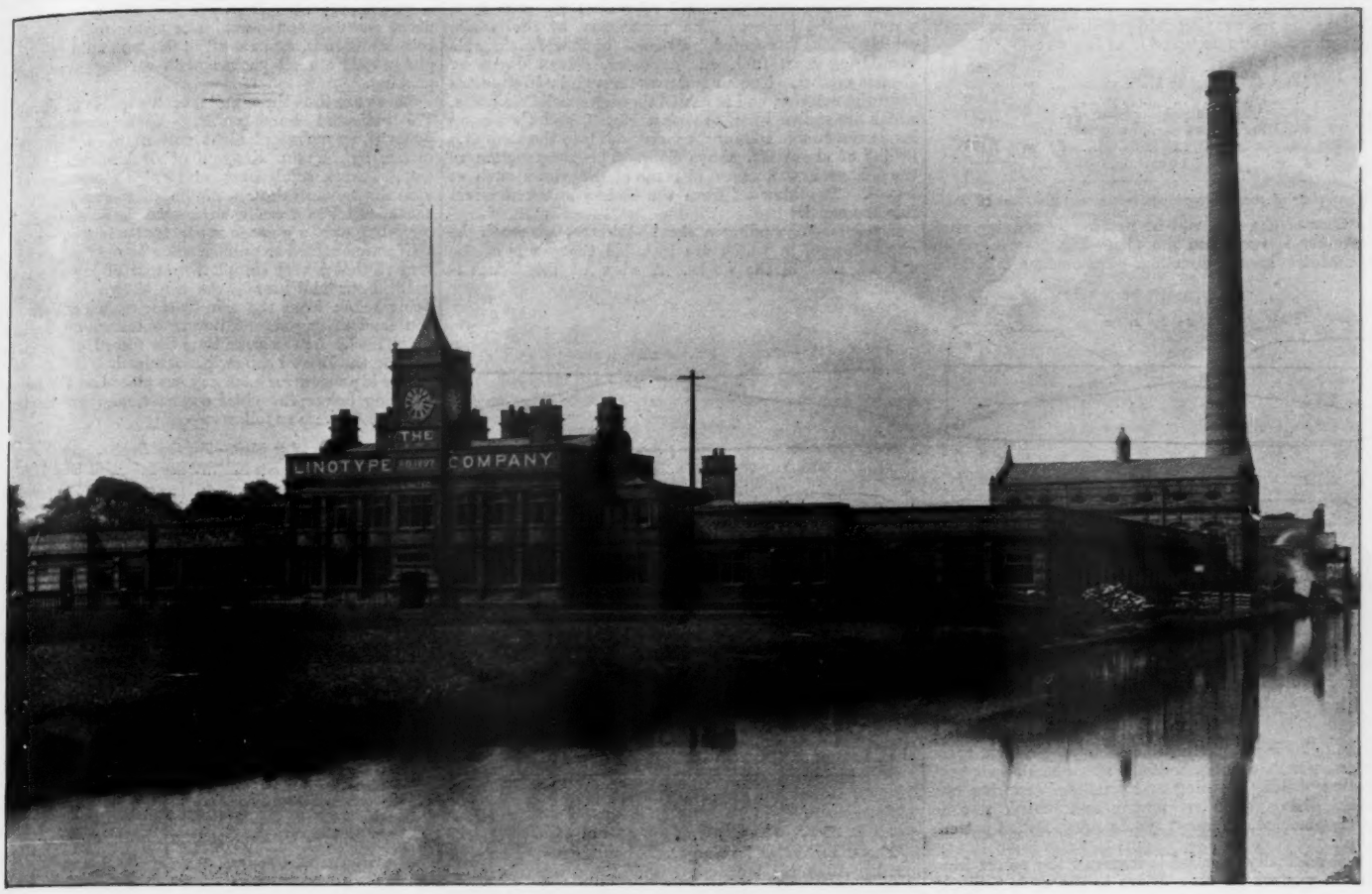


Fig. 1—GENERAL VIEW

ELECTRIC TRANSMISSION AT THE NEW WORKS OF THE LINOTYPE COMPANY.

THERE has been much discussion in recent years as to the relative advantage of transmission of power in workshops by mechanical and electrical means respectively. Some persons have stated that in all cases electrical transmission has distinct advantages over transmission by gearing, belting, and ropes; while others have expressed the view that the loss in mechanical transmission is not so large as has been stated, and that the plant for electrical transmission is far more expensive than that for mechanical transmission. In our opinion it is always far preferable to take note of what is being done practically than to enter into elaborate theoretical calculations. In the case of an old-established works where shafting and everything necessary for mechanical transmission is already in use, the expense necessitated for a complete change to electrical transmission is, of course, a very serious item, and it is absolutely necessary to consider each particular case upon its merits before being able to judge whether a saving would be effected. Broadly speaking, it is our opinion that where a number of small prime movers are being used it will be found preferable to substitute one central station with electrical transmission. The problem is much simplified in the case of a new works. We are in a position to describe a most interesting case of electric transmission of power in large new works, and we feel sure that the details we shall give will be found of great interest to our readers.

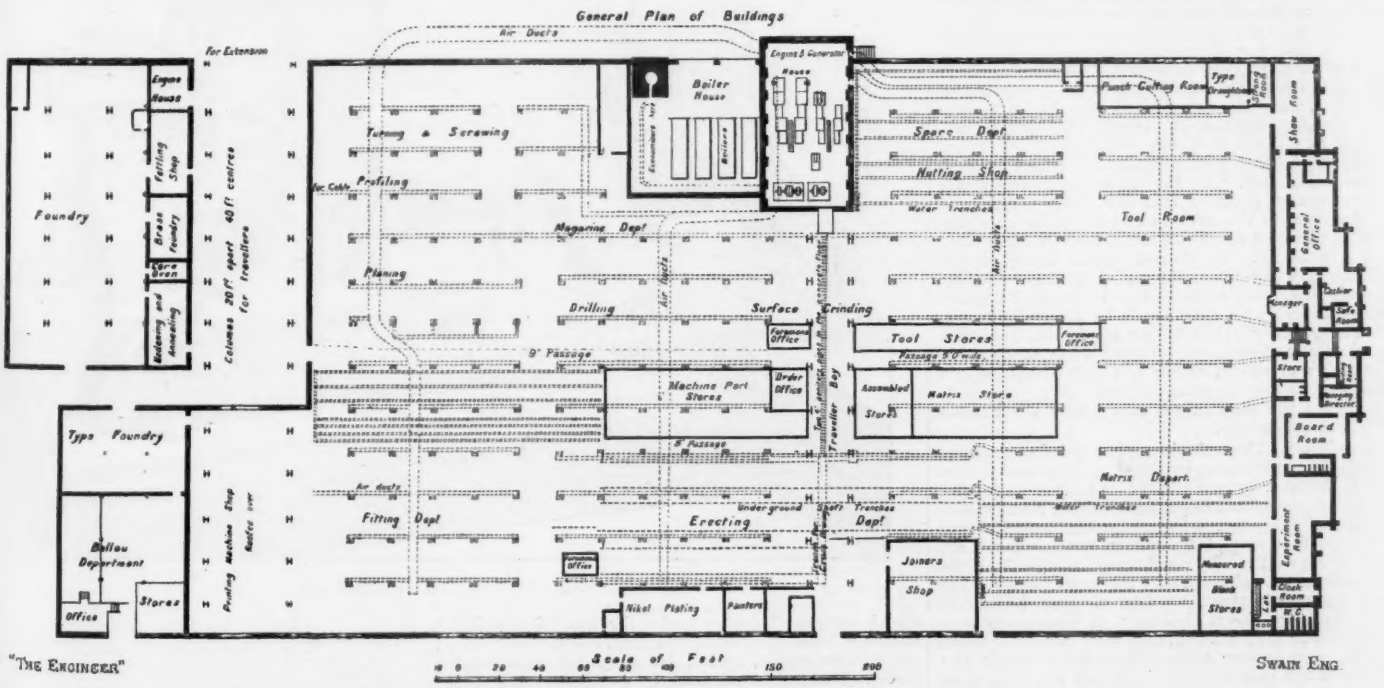


Fig. 2—THE NEW WORKS OF THE LINOTYPE COMPANY, BROADHEATH, NEAR MANCHESTER—GROUND PLAN

Most engineers must know the Linotype machine perfectly well by this time. The machine, which is a splendid example of mechanical design, was brought over to this country some years ago from the United States. Its manufacture was taken up in England, and the Linotype Company, Limited, was formed, with Mr. Joseph Lawrence as chairman, Mr. Lock as manager and secretary, and Mr. John Place, M.I. Mech. E., as chief engineer. The works of the company were, until recently, at Hulme-street, Manchester, and were somewhat inconveniently arranged upon seven floors in two buildings, and four in a third which had been previously used as a cotton mill, &c., and in the case of the seven-storey building, the ceilings were only about 9ft. high. The business rapidly outgrew the premises, and it was decided to acquire land outside Manchester. A large estate was therefore purchased at Broadheath, adjoining the Bridgewater Canal, and sufficient land was acquired to allow for very considerable future extensions and for building a large number of workmen's dwellings close to the works. By the courtesy of the management we recently had an opportunity of visiting this establishment, and found that the property owned by the company is very well situated for business purposes, as the Bridgewater Canal communicates with the Manchester Ship Canal; while Broadheath Station on the London and North-Western Railway, and Peel Causeway Station on the Cheshire line, are very near. Good macadamised roads are now being made everywhere on the estate, and about 150 substantial dwellings are completed, and we believe the company intends eventually to build about 500. A village is rapidly growing up around the works. The works buildings themselves are very

effective, and are faced with terra-cotta. Fig. 1 shows the office front and the canal. The drawing-office is well situated upon the first floor, and has a good light. Fig. 2 is a general plan of the works, showing the engine and boiler-house, &c. The entire works are upon ground level and upon the weaving shed principle, with saw tooth roofs, and the spaces occupied is as follows:—

	Sq. ft.
Main building, 460ft. long by 260ft. wide ...	= 119,600
Foundry	= 12,600
Ballou, typefoundry, and printing machines	= 7,200
Offices, including show-room, experimental room, and passages	= 7,800
Total	= 147,200

The number of persons employed is between 1100 and 1200.

Some idea of the size will be realised by noticing that the columns shown upon the plan—Fig. 2—are spaced at 20ft. centres in each direction. The business is divided into the following departments:—Tool, tachytype, type-drawing, punch cutting, milling, space-band, grinding, magazine, drilling, planing and profiling, screwing and turning, fitting, erecting, matrix and matrix testing, printing machine, foundry, typefoundry, Ballou pattern making.

It was originally intended to transmit the power from the main engines by rope drives to the main shafting, and thence by rope and belt drives to the countershafting; but the question of the most efficient system of transmission then received careful attention, and it was decided that electrical transmission had enormous advantages for such a work over any form of purely mechanical transmission. The engines had at that time been already ordered, and the engine-house arranged; the plant had therefore to be adapted to suit the type of engine which had previously been decided upon. As regards the general arrangement of the works, the whole of the centre of the building is occupied by the various stores, which are merely divided from the rest of the works by screens, consisting of woodwork 3ft. 9in. high, surmounted with wire netting giving a total height of 7ft. The general store is arranged so that all rough material is at the end furthest from the offices, whence it passes through the various operations, and is returned to the half near the stores office, and passes out on the other side to the fitting department, and thence either direct to the erecting department or to the assembled parts stores, which are conveniently placed with respect to the erecting department. It will thus be seen that all machining is done on one side of the building, and the work passes through the stores and is put together on the other side. In the matrix department the machines are so arranged that the matrices pass from one operation to the next machine, which does the following operation in regular order, so that there is no carrying to and fro. We do not propose in the present article to give a detailed description of the ingenious machines which are built by the Linotype Company, although naturally we shall allude to the work in passing. The primary object of our article is to lay before our readers a description of the system of electrical transmission of power, which has been found to give perfect satisfaction in practical use. We propose to begin where the fuel enters, and follow the lines of transmission of energy.

Boiler-house.—The boiler-house is situated as shown on the banks of the Bridgewater Canal, and fuel is delivered either by barge or by cart. The quality at present being used is that known as burgey, from Clifton Kersley, near Bolton, and the price, delivered into the engine-house, when brought on carts, is 8s. per ton in the summer and 8s. 5d. in the winter. By canal the price is 8s. 3d. in the barge, and 8s. 9d. delivered into the engine-house. The steam generating plant consists of four Lancashire boilers, built by Messrs. Galloway, of Manchester, each boiler being 28ft. by 7ft. 6in., and there are four conical tubes in each furnace tube. These boilers work at a pressure of 120 lb. per square inch, and two boilers are able at present to furnish all the steam required, as at this season no heating, and very little lighting, is needed. The consumption of coal is at the rate of five to six tons in twenty-four hours. At the side of the boilers is placed a Green's economiser, and the chimney stack is sixty yards high. The water at present in use is somewhat hard. Adjoining the boiler-house is a small room for the feed pumps. The ordinary supply of water to the boilers is provided by feed pumps worked direct off the main engines, but a duplicate plant is provided consisting of a No. 10 pump by Messrs. Dowson and Taylor, and this is arranged so that it can be used for fire-extinguishing purposes also. Water is obtained from the canal or from a private stream, and can be passed into the boiler direct, or through the economiser; each boiler is also provided with an injector as a stand-by. In the same room is placed a special pump by Messrs. Robert Dawson and Co., of Stalybridge, which is used in connection with the steam-heating apparatus and return of the condensed water to the boilers. The ventilation of the whole establishment is effected by means of four Blackman's ventilating fans, each 4ft. diameter, driven direct by electric motors. The air is drawn through large windows from the exterior, and is passed through special air ducts, which are shown upon the plan Fig. 2, and thence up inside the double columns, coming out into the shop at a height of about 6ft. above floor. The construction of the column is well shown in some of the views, such as Fig. 8. The blow-off from the boilers is taken direct into the canal.

Engines.—Ascending a short staircase, we reach the engine-house, in which are installed the whole of the engines used in the works. A view of this house is shown on page viii. On the left-hand side will be seen a side-by-side horizontal compound condensing engine by Messrs. Goodfellow, of Hyde, near Manchester. The high-pressure cylinder is 12in. diameter, and the low-pressure 23in. diameter, with a stroke of 36in.

The steam after leaving the low-pressure cylinder is condensed in a jet condenser, and the water and gases expelled by a vertical air pump. Each engine works on to a separate crank fitted on one end of a common shaft, which carries a rope pulley 15ft. diameter grooved for eight 1¼in. ropes. These engines will comfortably indicate 175-horse power with 120 lb. steam pressure. On the right side of the engine-house will be seen a tandem horizontal compound Corliss engine by the same maker, having cylinders of precisely the same size as those of the side-by-side engine, and it developes the same horse-power. Since this photograph was taken a similar engine, but opposite hand, has been coupled on to the same crank shaft and the fly-wheel made double the width, so that it now has sixteen grooves for 1¼in. ropes; the two tandem engines will each comfortably indicate 175-horse power.

Both sets of engines are neatly and strongly built. All the cylinders, both high and low-pressure, are fitted with separate steam and exhaust valves on the Corliss principle, the inlet valves being worked by an improved trip motion giving any point of cut off which may be required, from zero to seven-tenths of the stroke, those in the high-pressure cylinder being automatically actuated by high-speed governors without the intervention of throttle valves or other governing apparatus. There is attached to each governor a very neat appliance for immediately cutting off all steam and breaking the vacuum in case the governor should ever fall to its bottom position or rise above any desired position, so that the engine is prevented from running at a dangerous speed under any circumstances. The piston-rods, crossheads, connecting-rods, &c., are all of the best mild steel. The piston-rods are all packed with an improved metallic packing.

There are thus three units, each capable of developing 175 indicated horse-power. Each engine drives a dynamo, by means of eight cotton ropes, 1¼in. in diameter, by Messrs. Kenyon, of Dukinfield. All these engines work condensing, and on the occasion of our visit the vacuum showed 27·6in. of mercury. Indicator cards are taken from each engine daily, and a Bristol's recording pressure gauge is constantly in use.

We are enabled to publish some of the cards, and may remark that a very complete system of log sheets is in use. Four indicator cards are shown in Fig. 4, two being taken from the side-by-side engine and two from the tandem engine. All were obtained on September 20th, 1898. At the same time the record of steam pressure on the Bristol gauge was obtained.

The log sheets for each day are placed on the following morning before the chief engineer, and for September 20th, 1898, were as follows:—

Log Sheet.—Tandem Engine.

Start, 7 hours 15 min.	1 hour 17 min.
Stop, 12 hours 30 min.	6 hours 20 min.
Average pressure per square inch during the day's run	116 lb.
Average vacuum per square inch during the day's run	13·3 lb.
Revolutions per minute	75
Oil used	6 pints
,, cylinder	6 pints
,, castor	2¼ pints
Remarks	All working well

Log Sheet.—Side-by-side Engine.

Start, 7 hours 25 min.	1 hour 25 min.
Stop, 12 hours 30 min.	7 hours 20 min.
Average pressure per square inch during the day's run	116 lb.
Average vacuum per square inch during the day's run	13·5 lb.
Revolutions per minute	75
Oil used	13 pints
,, cylinder	12 pints
,, castor	5 pints
Remarks	All working well

Boiler Log Sheet.

Boiler No. 2 fired up	Under steam night and day
Boiler No. 3 fired up	,, ,,
Pressure during day's run	116 lb.
Boiler fluid used	10 pints of soda
Coal used	5½ tons per 24 hours
Economiser in use	Yes
Temperature of feed-water ...	260 deg. Fah., average
Remarks	

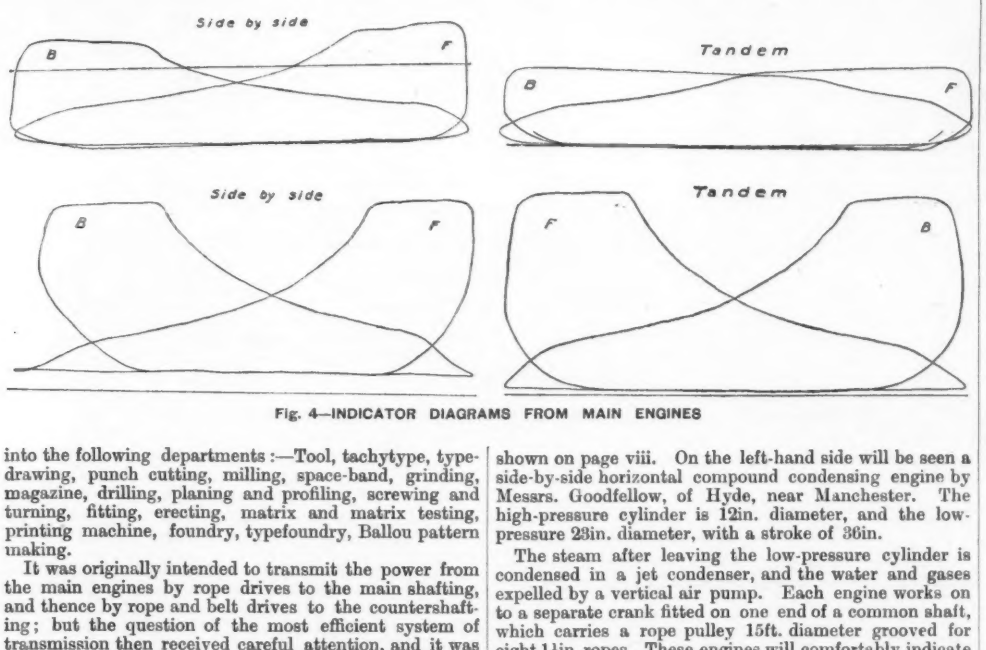


Fig. 4—INDICATOR DIAGRAMS FROM MAIN ENGINES

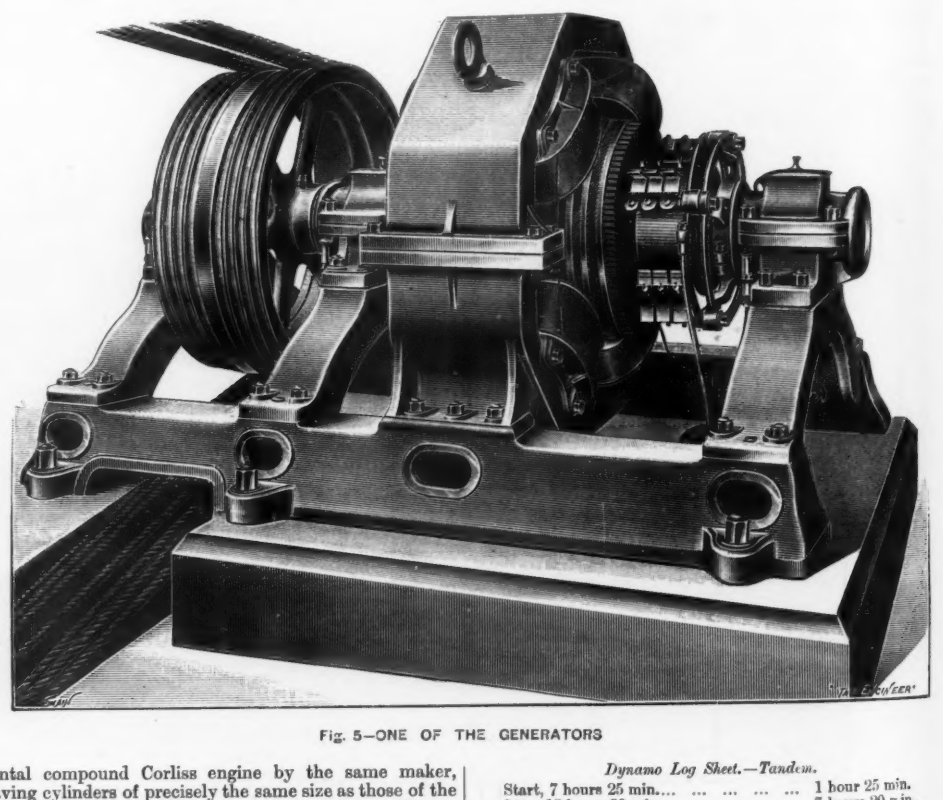


Fig. 5—ONE OF THE GENERATORS

Dynamo Log Sheet.—Tandem.

Start, 7 hours 25 min.	1 hour 25 min.
Stop, 12 hours 30 min.	6 hours 20 min.
Ampères	350, average
Volts	212, average
Brushes	Good
Sparking	Slight
Remarks	

Dynamo Log Sheet.—Side-by-side.

Start, 7 hours 15 min.	1 hour 17 min.
Stop, 12 hours 30 min.	6 hours 20 min.
Ampères	350, average
Volts	212, average
Brushes	Good
Sparking	Slight
Remarks	Working well

On page x[i]. will be found a sheet taken upon the recording voltmeter, and also one from the recording ampèremeter, both on the main distribution board.

These are for September 20th, 1898. On the current curve the exact time of starting and stopping of the various departments can be clearly seen, and also the mealtimes. The instrument does not appear to have been reading from zero; possibly the paper was not accurately adjusted.

We also give a current curve for February 24th, 1898, which clearly shows the peak about 6 p.m., due to the electric lighting. It will also be observed that part of the works only began running at 8 a.m., as is usual on Monday mornings.

Dynamos.—Three dynamos are driven by the three engines, all of them being built by Messrs. Mather and Platt, of Manchester—one is shown in Fig. 5. Each developes 210 volts and 500 ampères at a speed of 275 revolutions per minute. They are of the four-pole type, shunt-wound, and will give 700 ampères output for a short period. The efficiency is stated to be 92 per cent.; that is to say, $\frac{\text{B.H.P.}}{\text{E.H.P.}}$. The brushes are of the compound form, as improved by the Linotype Company, consisting of carbon with copper gauze inside, and each machine has four sets of three brushes in parallel. The switchboards are fixed in the end wall of the engine-house, and are not very clearly shown in the photograph, as the work was not entirely complete.

Switchboards.—The switchboards consist of slate panels mounted upon tee iron framing carrying the various instruments and switches. Upon the right-hand is the main dynamo board carrying three double-pole double-break main switches for 700 ampères, with double-pole cut-outs, each consisting of five spring clip fuses capable of passing 140 ampères each. The switches are mounted upon two main bus bars, and room is left for a fourth dynamo. As the dynamos are shunt-wound they can all be put in parallel with perfect ease. The distribution board is of similar type, and placed on the left of the engine-room. This board is provided with four switches for 350 ampères, seven for 250 ampères, and four for 150 ampères; the type of switch and fuse is shown in Fig. 6. Upon the main distribution board are fixed a Kelvin recording voltmeter and a Richard recording ampèremeter. The engine-house is lighted by four 5-ampère Jandus arc lamps. Besides the plant already alluded to, there is a small direct-coupled set consisting of a Willans G G type engine, developing 80 indicated horse-power, coupled direct to a Siemens dynamo giving 200 ampères at 210 volts. From the main distribution board are carried india-rubber covered cables, made by the Helsby Telegraph Company, Limited, and run in wood casing, each feeder supplying a sub-distribution board. The sub-distribution boards consist of slate panels, upon which are mounted gun-metal bus bars and double-pole switches of the same type as those already described upon the main distribution board.

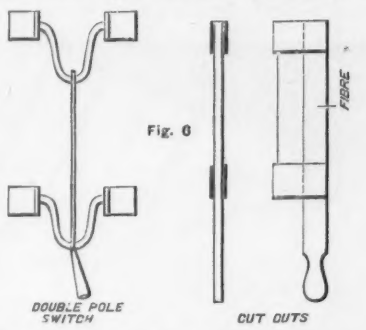


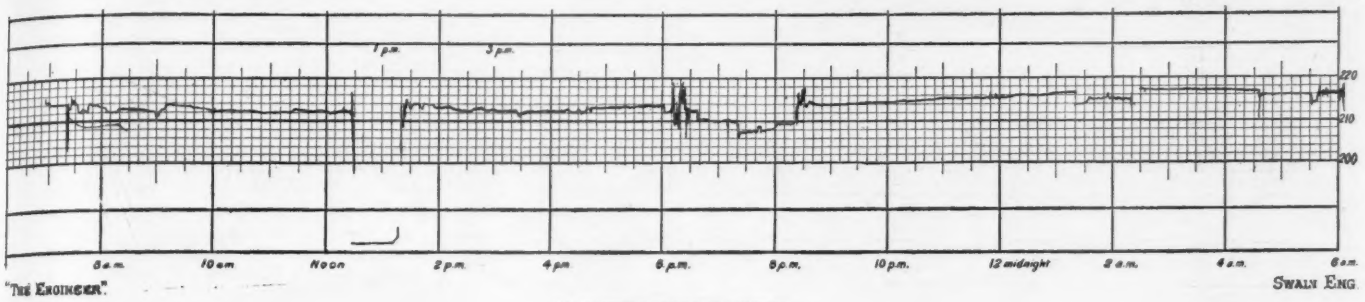
Fig. 6

Each branch board supplies both lighting and power circuits in the particular area which it controls. This is an interesting point, as it might be considered that fluctuation in the potential would constantly occur, affecting illumination afforded by the lamps. On inquiry, however, we learnt that no difficulty has occurred upon this score. Mr. Charles Hopkinson, B.Sc., M.I.C.E., brother of the late Dr. Hopkinson, then a director of the Linotype Company, of Manchester, acted as consulting engineer, and Messrs. Drake and Gorham were the contractors.

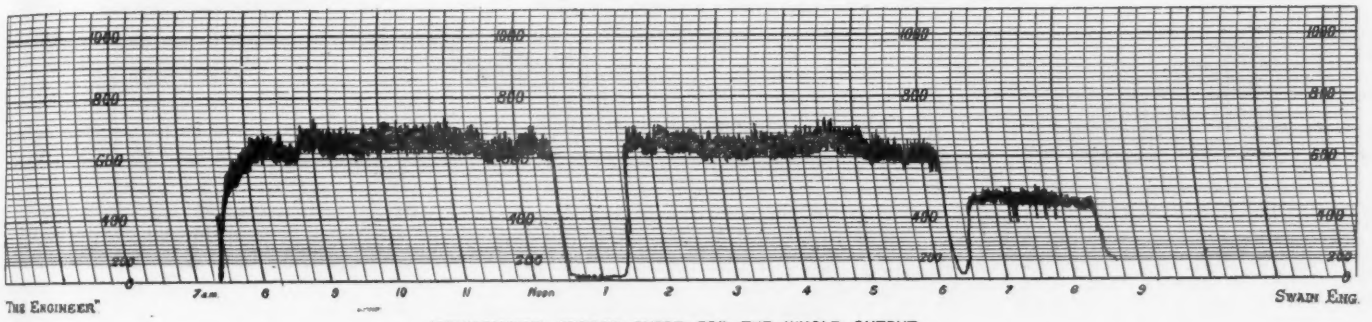
Transmission.—We now come to the system in use throughout the works when it was finally decided that this method of transmission should be adopted instead of transmission by main shafting and belting. It was decided to divide the whole works into units of 5-horse power or 10-horse power. As will be seen later the bulk of the machine tools are of light character, taking only a small amount of power; it was therefore thought advisable to group them as already stated. The whole of the line shafting is 2¼in. diameter, and is supported at intervals of 10ft. by means of bearings, each alternate bearing being fixed to a column. Fig. 7 shows the method adopted for fixing the hangers to the girders. A general examination of the various photographs will show that belting has by no means been entirely displaced, but what remains is of a light form, and is not likely to cause a great loss in transmission. The whole of the shafting is run at 200 revolutions per minute, and was originally put up in lengths of from 80ft. to 100ft., with intermediate couplings. In arranging the machines each motor was then loaded up to its full capacity, and where necessary couplings were removed, and new motors put down for the remaining portions of the shaft. The whole of the motors are shunt-wound, and were built by the following makers:—Messrs. Mather and Platt, of Manchester; Messrs. Holmes and Co., of Newcastle-on-Tyne; Messrs. Greenwood and Batley, of Leeds; and a few small motors by Messrs. Cuttriss Wallis and Co., of Leeds. Each motor is mounted upon a wooden lead-lined tray, and is protected with an iron railing covered in some cases with strong wire netting. The arrangement will be seen in Figs. 8 and 8*a*, which shows a number of small milling machines. The wire netting on this particular machine has not yet been fixed. The starting switches are of various types, and many of them are in our opinion not very satisfactory. We consider it extremely desirable that each switch should have a "no voltage" automatic release, so that any switch can be controlled from the sub-distribution board without the necessity for going to the machine itself to switch off. Such an arrangement prevents the fuse being melted, an accident which may easily occur with the ordinary starting switch without an automatic release. Such an occurrence is extremely annoying and expensive in a large works, as the mere melting of a single fuse may stop twenty or thirty men for perhaps a quarter of an hour.

If, however, the "no voltage" type of switch is used, the current can be switched off at the sub-distribution board, and there is no necessity for visiting each particular machine. When it is necessary to start work again the switch upon the board must first be put on, and then the switch of the particular motor must be put on afterwards. We have ourselves made careful inquiries as to the types of starting switch which are most commonly used at present, and we find nothing whatever produced in Great Britain to touch the special switches produced in the United States. These switches are made of standard sizes and shipped over to this country by the hundred. No British maker, so far as we are aware, has considered it worth while to design such a standard series. Most of those made by firms in this country are strong and well built, but are far more expensive than the American article, and have no automatic releasing arrangement whatever.

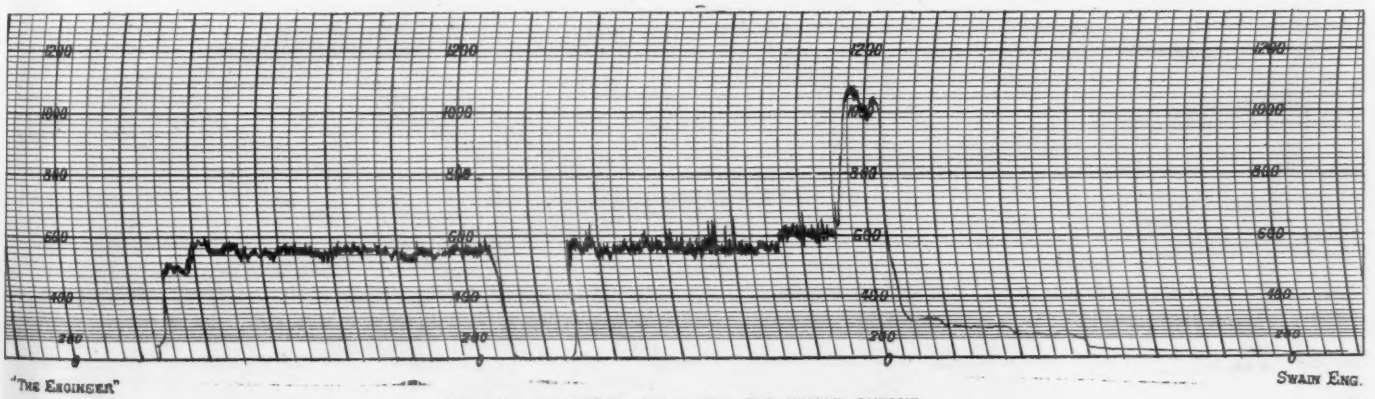
It is, of course, very desirable to be able to test each individual motor, and to be able to see exactly what work it is doing. We should have liked to have seen a neat arrangement of recording ampèremeter mounted upon each of the sub-distribution boards, but possibly that would be too expensive an arrangement. It is, however, in our opinion, essential that such an instrument should



VOLTMETER RECORD SHEET



AMPEREMETER RECORD SHEET FOR THE WHOLE CUTFUT



AMPEREMETER RECORD SHEET FOR THE WHOLE OUTPUT

THE LINOTYPE COMPANY'S WORKS, BROADHEATH, NEAR MANCHESTER

(*For description see page* xi.)

Fig 8—THE MILLING DEPARTMENT

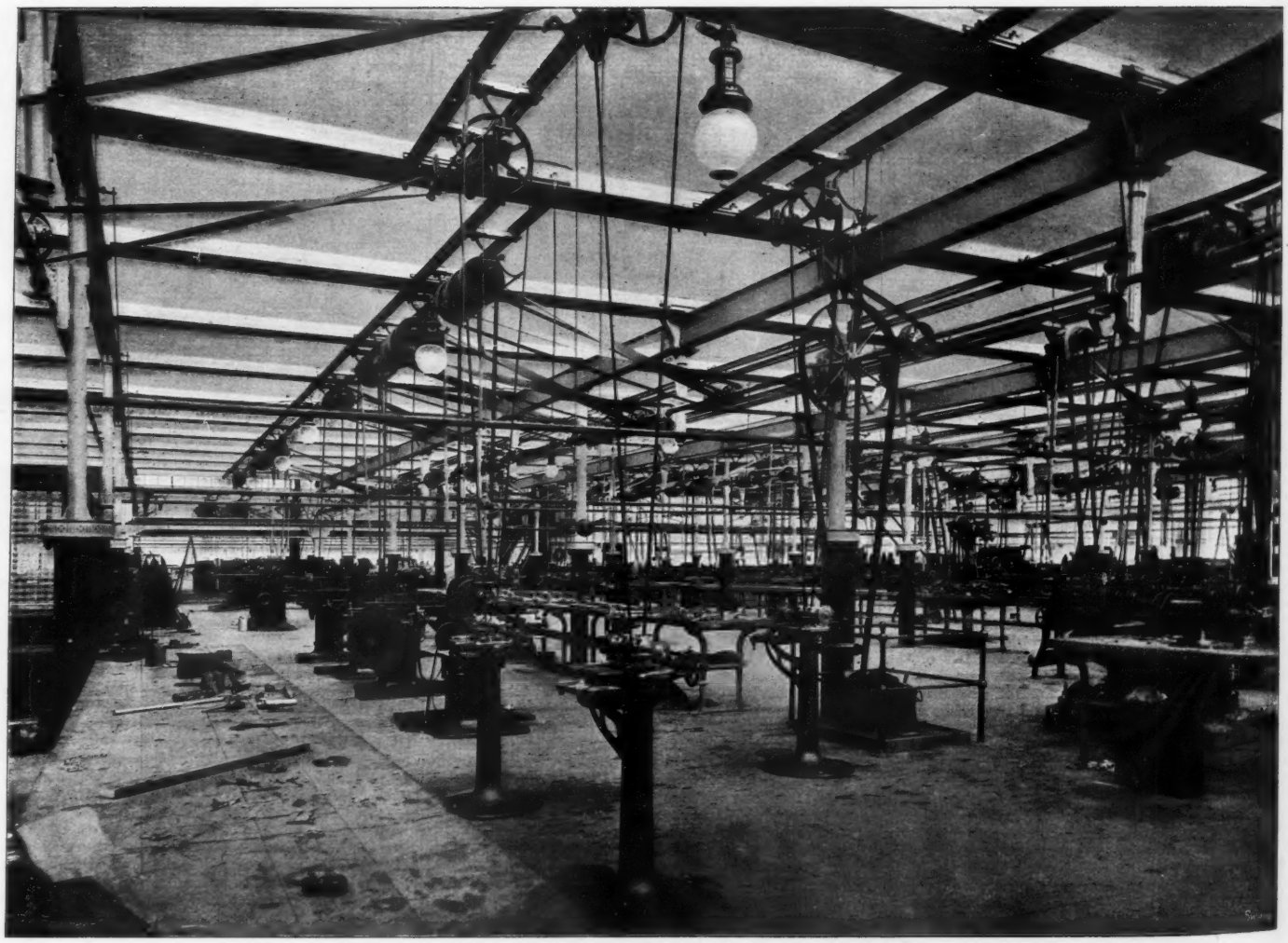


Fig. 8a—THE MILLING DEPARTMENT

be used if a trustworthy opinion is to be formed of the behaviour of any given motor. This apparatus has not yet been provided in a portable form, although the total load, that is to say, the current used for lighting, and that used for power, taken together, is recorded upon the main distribution board. A portable arrangement, consisting of an ordinary ampèremeter and voltmeter, is used, and with this apparatus Mr. Place has obtained some very valuable information which we publish below. Such results as these should cause emulation, and if we can induce others to bring forward their results we shall have conferred a benefit upon our readers.

The special series of tests which we give below were made upon 1st September, 1898, and although it was impossible to obtain data from all the motors, these results may be considered thoroughly characteristic engine tests. The side-by-side compound condensing engine indicated 126·73-horse power with a boiler pressure of 120 lb. per square inch. The electrical energy produced was 99·44-electrical horse-power, being 350 ampères at 212 volts.

Motor tests.—A 5-horse power Mather and Platt shunt motor, with slotted armature core and carbon brushes, and running at 850 revolutions, drove by belting 40ft. of 2¼in. shafting at 200 revolutions per minute in six bearings, from which were belted three Pratt and Witney milling machines, Lincoln pattern; two Brown and Sharpe milling machines, No. 0; four small milling machines; two small grinders. The energy absorbed was 14 to 17 ampères at 202 volts, or 3·8 to 4·6-horse power. Another 5-horse power was driving 100ft. of 2¼in. shafting at 200 revolutions in twelve bearings, and ten countershafts light; energy absorbed, 8 ampères at 204 volts, or 2·2-horse power. A 10-horse power motor running at 1050 revolutions light absorbed 8·75 to 10 ampères at 210 volts, or 2·8-horse power. Running 140ft. of shafting 2¼in. diameter in fifteen bearings at 200 revolutions, carrying twenty-seven pulleys, varying from 12in. to 20in. diameter, it absorbed 13 to 14 ampères at 210 volts, or 3·95-horse power; and when running sixteen countershafts with twenty-four belts it absorbed 20 ampères at 210 volts, or 5·6-horse power. A 20-horse power Lundell type of motor by Messrs. Holmes and Co., running 60ft. of 2¼in. shafting in eight bearings, and driving twenty. two Brown and Sharpe surface grinders, absorbed 60 ampères at 210 volts, or 17-horse power.

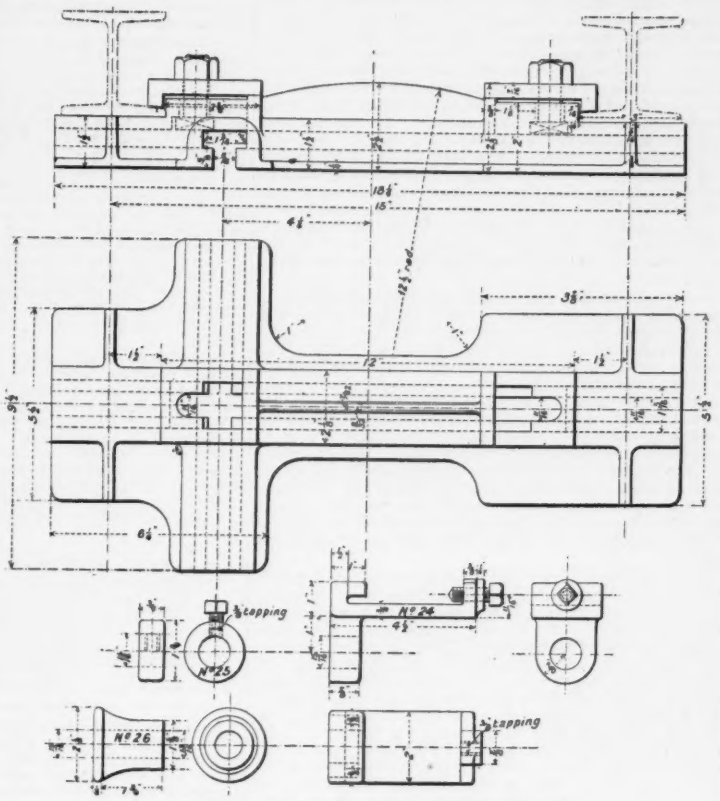


Fig 7—DETAILS OF BEARERS FOR COUNTERSHAFTS

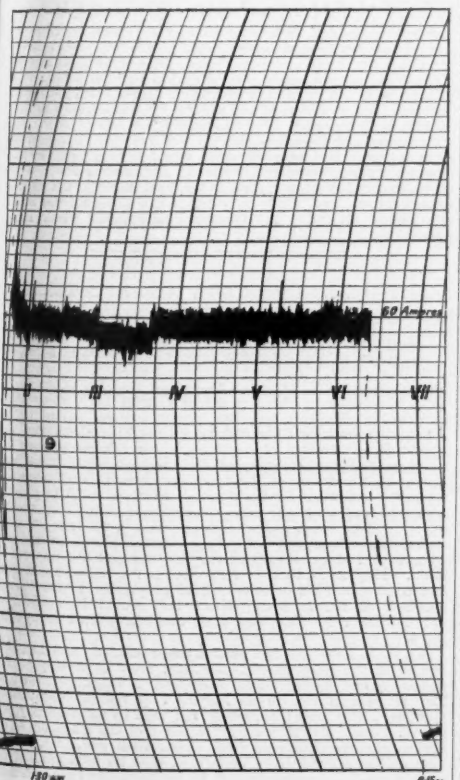


Fig. 9—AMPERE RECORD FROM ARC MOTOR

Some interesting tests of power required to run the shafting were then made. A 5-horse power motor was first tested light at 950 revolutions, and absorbed 2 ampères at 204 volts, or 0·55-horse power. It was then connected by belting to a 2¼in. shaft, 93ft. long, in ten bearings, and this shaft was then run at a speed of 200 revolutions per minute, and the energy absorbed was 0·98-horse power, so that the shafting alone took 0·43-horse power. Another test under the same conditions gave 0·98 and 0·57-horse power, so that the shafting alone took 0·41-horse power; the average was therefore 0·42-horse power, or 0·04-horse power for each of the bearings, supposed all to be equally stressed. A 10-horse power motor running light—that is to say, with no belt upon it—absorbed 6 ampères at 202 volts, or 1·63-horse power, and when driving by belting a shaft 130ft. long and 2¼in. diameter, in sixteen bearings, it required 9 ampères at 202 volts, or 2·45-horse power; the power necessary for the shaft alone was therefore 0·83-horse power, or about 0·052-horse power per bearing. Fig. 9 is a diagram obtained by means of a recording ampèremeter of the energy consumed by the 20-horse power motor driving the grinding machines. It will be seen that the consumption is fairly constant at about 60 ampères from about 3.45 p.m. to 6.15 p.m., and the motor was giving out about 16·5-horse power. We noticed that the driving was effected by two single belts, one put on top of the other, and this system appears to be used in many instances throughout the works, the upper belt being always slightly loose upon the lower. The shafting is placed about 10ft. high, and its centre line and the couplings are worthy of note. These are formed of two split cast iron sleeves with taper ends, as shown in Fig. 10. Upon each end a solid wrought iron ring is driven with a few light blows, and the ends of the shafts are drilled and slotted out in the manner illustrated, and a key of dumb-bell section is dropped in. These couplings are stated to give every satisfaction, as they can be so easily dismounted. When the shaft is not actually giving off power, it is possible to hear a slight click caused by the key inside, which is left quite free.

The arrangement affords an easy means of adjusting loads upon special motors if it be found necessary to do so. At the present time about seventy-seven motors are in use; the 5-horse power type, by Messrs. Mather and Platt, will take 22 ampères and keep cool. There are other motors of 12 brake horse-power; these have somewhat bulky resistance coils in a large cylindrical box. While we were in the works, we noticed that one of the 10-horse power motors was using 40 ampères, and another 34 ampères at 204 volts. The actual drop in potential of course depends upon the precise current which is being used at the time. In the grinding department, to which we have previously alluded, there are fifty Brown and Sharpe surface grinders. These are used for grinding pieces which are glass hard to dimensions which must not vary the thousandth of an inch. One man attends to each pair of these machines. The 20-horse power motor previously referred to is driving twenty-six of these machines, and a considerable saving is effected by the grouping, as an experiment proved that the fuse of a 5-horse power motor melted when it was driving only four machines.

The method of protecting the leads to the motors is also very satisfactory; the ordinary wood casing is run along the framing of the roof, and the leads are passed down a pillar of gas pipe, having a flange at the bottom, supported upon a wood block cut away to allow the leads to pass out. The cables enter at the top, and pass out to the starting switch through a wrought iron tee-piece bushed with wood, and then down to the floor inside the pipe, and along to the motor.

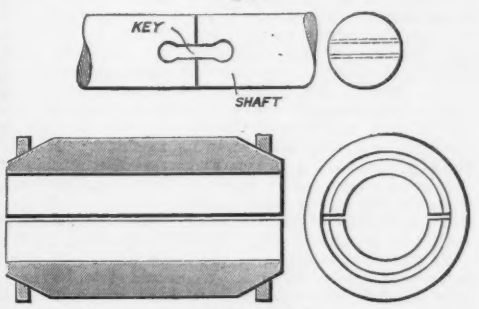
One 5-horse power motor of which we obtained details was driving 100ft. of 2¼in. shaft at 200 revolutions in twelve bearings; it was absorbing 38 to 45 ampères at 204 volts, and from the shaft were driven one No. 5 Brown and Sharpe's plain milling machine, not geared; five No. 4 universal milling machines, six No. 3 universal millers, six No. 2 plain millers, two No. 3 plain millers, and a gear cutter by Gould and Eberhardt; in all therefore twenty-one machines, of which twenty were built by the Brown and Sharpe Manufacturing Company. This department is shown in Figs. 8 and 8*a*. The floor of the shops is partly of boards and partly of wood blocks, the latter system being adopted where the heavier work is carried out. The stanchions and the girders are all of cast iron, and we understand that this effected a saving in the cost upon what would have been necessary if wrought iron had been used. The cross joists carrying the hangers are all of rolled steel, and the special system of fixing shown in Fig. 7 has been found very satisfactory. The whole of this large shop is lighted by means of Jandus arc lamps, using 4 to 6 ampères, and placed 20ft. apart in each direction; they are hung about 8ft. high, and are said to afford good illumination. They are, of course, fed, too, in series, as the supply is of about 210 volts pressure. There are at present 288 arc lamps in use, and 250 incandescent lamps in the offices and elsewhere; it will therefore be seen that the energy consumed in the lighting of the works is something considerable. There are now about 600 machine tools installed, and about 3500ft. of shafting, exclusive of the countershafting.

Type Making.—We were much interested in the punch-making department, where the Benton Waldo-punch-cutting machines are at work. The machines cut out the punches used for the production of the brass matrices for the Linotype machine. The process is one of reduction from a large pattern. The machine consists of a rotary cutter of extreme fineness which is fixed, and the punch being cut is held in a chuck, free to slide in any direction, and is controlled by a long pendulous leg, on the end of which can be placed a roller, which is guided round the periphery of the pattern. When beginning to cut the punch a roller about 1½in. diameter is used, and after going once round a smaller roller is used, and so on until the pattern is traced with practically a pin's point, and the rotary cutter produces a reduced facsimile in the form of a punch cut out of the solid steel. The extreme delicacy of the cutter will be appreciated when we state that it produces the letter X for ruby type, which is only 0·074in. high from top to bottom, and has angles of remarkable acuteness. After being hardened the punches are used in the matrix department for punching the brass matrices, of which many thousands per week are turned out.

Miscellaneous.—In the screwing department the machines are arranged *en echelon*, in order to allow of the use of very long bars, and a curious and interesting fact was pointed out in this department. The bars used are beautifully finished, quite bright, and look as though they had been turned in a lathe. We found that they were of mild steel, cold-rolled to Whitworth gauge, and that they were of American make, and perfectly satisfactory. They could be cut quite easily, as the material was beautifully mild. These bars can be procured of all sizes up to 1in. diameter at £13 per ton, whereas the bars which were supplied by Sheffield firms, and supposed to be similar, cost £23 to £24 per ton, were of irregular size, and so hard and unequal that the material was useless.

The store department in the centre of the shop occupies a very large area; there is also a special part set aside for testing matrices, every single matrix being actually cast and a proof taken off before being sent out. The foundry is a fine shop provided with an electric travelling crane to lift 10 tons; it has three separate motors, and gives an absolutely steady lift; we saw it raising moulds and turning them over without shaking the sand in any way; it has a span of 28ft. 10in., and lifts at a speed of either 3ft. 9in. or 10ft. per minute, and travels transversely at a speed of 50ft., and longitudinally at a speed of 180ft. per minute; this was built by Messrs. Craven Bros., of Manchester, and the motors supplied by Messrs. Hall and Co., of Oldham. The drying-room is provided with a large gas Bunsen flame with flexible india-rubber tube. There are two cupolas, and a 6-horse power motor is used for the cupola lifts. This motor is kept constantly running whether the lift is actually in use or not. A blow is made ready every day. A 20-horse power motor is employed for driving the cupola blast and the smiths' fires and hardening furnaces, while a small steam engine is kept as a stand-by in case of accident. In the despatch department there is an electric travelling crane fitted with three motors and capable of lifting five tons. It has a span of 18ft. 10in., and will lift at speeds of 5ft. or 12ft. per minute. It travels transversely at 60ft. per minute, and longitudinally at 200ft. per minute, and was built by the same makers as the crane already described.

Fig. 10



SHAFT COUPLING

Although we have made no attempt to describe the machines made by the Linotype Company, we cannot close this article without alluding to one or two special varieties which are now being made. The Linotype feeder for printing machines appears to be one of the new standards, and the department in which the Ballou engraving machine is at work is well worth a visit. This is a very beautiful machine, and obviates the necessity for the use of punches for producing the matrices, as it engraves the letter direct upon the brass itself. It appears to turn out very accurate work, which is, of course, quite free from the rough edges produced by punching. Girls were attending to these machines, and it appeared scarcely possible to make mistakes, as the rotary cutters are guided by the passage of a guide roller round a large pattern, in a similar manner to that in use in the punch cutting department. The matrices produced are said to be finer and sharper than those punched, and the production of linotype work is considerably better.

Upon inquiring as to the actual cost of producing the electric energy, Mr. Place kindly furnished the following figures. The side-by-side engine on 1st September, 1898, gave 126·73 indicated horse-power, the dynamo output was 212 volts and 350 ampères, which is equivalent to 99·46 electrical horse-power. There was, therefore, a loss of 27·27-horse power and a commercial efficiency of nearly 80 per cent. It must be remembered that rope driving is used. We were informed that while the actual works cost of production of energy at the Manchester City Electric Light Station is 1·11d. per Board of Trade unit, inclusive of cost of coal, engine-house expenses, and wages, but exclusive of capital expenditure, the relative cost at the Linotype Company's works is 0·94d., which is, of course, extremely favourable. It must, however, of course, be borne in mind that the load factor at Broadheath is a very good one, as the power is in constant use throughout the day, whereas in the city of Manchester lighting is the chief demand.

Before leaving we visited the drawing-office, which is well appointed, with very convenient desks fitted with drawers, and Mr. F. C. Dolby, the head of the drawing office, explained the admirable system adopted in registration of drawings. Blue prints are used throughout the works mounted on straw board, and the prominent line "keep rules off" is very necessary, seeing that the work must be carried out to the $\frac{1}{1000}$ of an inch.

After visiting such a works as that we have just described, and considering the various points quietly afterwards, one must be struck with the view that the principal part of the machinery, the method of working, and the design of the objects made are all distinctively American. We made careful inquiries on this head while passing round the various shops, as we noted machine after machine with the United States label. Why is it that we have to go to the States for tools which might perfectly well be produced here? That question may be followed by the more general one, Why are American raw or partly-finished materials, and also highly-specialised products, ousting the home-made articles? The matter divides itself into two different parts: (*a*) the raw or only partly-finished material; (*b*) the finished product. The answer to the first part of the question is probably this, that the materials are used close to the site where they are found, and that the carriage, although high, does not counterbalance the extra cost of production in Great Britain, but the latter part of the question is more difficult to answer, seeing that under heading (*b*) labour is the chief item, and this is far more expensive in the States than here. The only answer we can give is, that more is got out of the workman in the States, and that standardisation and building for stock are always followed. We were informed that certain machines could not be obtained under fourteen months in England, whereas the order was placed with the London house of an American company on a Friday and the tools were at work in the shop ten days after. Without any desire to advertise American products, we may just mention that the following firms, among others, supplied the tools. The Brown and Sharpe Manufacturing Company, of Providence, Rhode Island, U.S.A., supplied milling machines, surface grinders, and universal grinders; Messrs. Pratt and Witney, of Hartford, Connecticut, accurate planing machines and automatic screwing machines; Messrs. Reed and Co., lathes; Messrs. Flather, planing machines; the Cleveland Automatic Screwing Company, Cleveland, Ohio, their special machines; Hardy and Norton, lathes, and the Prentice Machine Tool Company supplied radial drills and sensitive drills. Generally speaking, British tools are not so accurate at the same price, and quick delivery cannot be obtained. We should state, however, that the following British firms have supplied satisfactory tools:—Archdale and Co., Birmingham; Campbells and Hunter, Leeds; Shepherd and Hill, Leeds; Craven Bros.; Muir and Co., and Kendal and Gent, all of Manchester, and Messrs. Richards, of Broadheath. If the latter firm had not been so busy they could have supplied more tools than they actually did, and quite equal to the American types. We think it quite worth while to direct the careful attention of toolmakers to the points raised, as we feel perfectly satisfied that there is no valid reason preventing the supply by British firms of all the tools required in British shops.

NIAGARA FALLS.—To hold its rights on the Canadian side of Niagara Falls, the Canadian Niagara Power Co., which is controlled by the Niagara Falls Power Co., is required to pay an annual rental of £5000 to the commissioners of Queen Victoria Niagara Falls Park. This agreement was entered into in April, 1891, and further provides that the company shall have 10,000 developed horse-power and water connections for 25,000-horse power by November 1st, 1898. Some months ago an extension of time was asked and allowed, and the company was permitted to install two 500-horse power generators in the station of the Niagara Falls Park and River Railway. It has been reported in Canada that the company would voluntarily forfeit its rights, but on October 18th the half-yearly rental of £2500 was forthcoming, thus proving the company's intention to hold its rights to develope power on the Canadian side.

A LONG ELECTRIC RAILWAY.

THE new electric railway from Chicago to Waukegan, thirty-one miles, will be operated entirely from one power station, by means of an interesting combination of direct-current and three-phase alternating-current transmission. To operate the line by direct current alone would have involved an enormous and prohibitive expenditure for copper for the large feeders required, and it was not considered that a reasonable degree of efficiency and economy could be obtained by the use of two power stations, or of a single station supplemented by a booster equipment. The system adopted consists of a combination distribution system, with a power station near the middle of the line. The sections of the railway adjacent to the power station are supplied with direct current from the station, while the more distant sections get their supply of current from sub-stations, each containing a rotary converter, consisting of a three-phase alternating-current motor, and a direct-current generator combined in one machine. The sub-station motors are supplied with power over a high-tension transmission line, consisting of three small copper wires exending back to the power station. The direct current from each sub-station is distributed to the trolley by means of the usual system of feeders extending in both directions. The location of these sub-stations, and their distance apart, are governed by the conditions of traffic, and somewhat by the nature of the gradients.

The power station will contain three horizontal Corliss compound condensing engines, one of 400-horse power and two of 800-horse power each, and these will be directly connected to five dynamos of 250 kilowatts capacity each. The engines run at 125 revolutions per minute, and are designed so as to be capable of safely standing an overload of 100 per cent. on emergency when high-pressure steam is admitted to the low-pressure cylinder through the receiver by means of a reducing valve. The engine and dynamo shafts are all in line, and are connected by the Arnold system. The generators are mounted on hollow shafts, through which passes the main shaft, and suitable couplings enable any one generator to be run by either one of two engines. Thus, engine No. 1 can drive dynamo No. 1 or No. 2, or both of them; while engine No. 2 can drive any one or all of four dynamos.

Three of the dynamos are alternating-current dynamos with twenty-four poles, delivering a three-phase current of 25 cycles per second, which is generated at a potential of 5500 volts, and delivered directly to the transmission lines without the use of transformers. The other two dynamos are combination machines, which can deliver their full capacity either as direct current or as three-phase alternating current. Each of these dynamos has but one armature, the windings of which are connected to collector rings on one side, and to a commutator on the other side. It can thus supply current to the overhead wires of the sections adjacent to the power station, or supply current to the sub-stations of the distant sections. The potential of the direct-current end is 600 volts, while that of the three-phase current is delivered at a voltage of 380 volts. When this latter current is transmitted to the sub-stations, its potential is raised to 5500 volts by means of static transformers at the station.

COST OF PRODUCING ELECTRIC POWER BY WATER POWER FROM THE LACHINE RAPIDS, CANADA.*

THE Lachine Rapids are situated on the St. Lawrence River, a short distance above the city of Montreal, and as far back as 1866 a company was formed whose object was to erect dams and construct large hydraulic works, the object being to induce factories to establish their works at the rapids, for at that date the possibilities of electric transmission had not been demonstrated. The scheme, however, never matured.

In the autumn of 1895 the Lachine Rapids Hydraulic and Land Company, Limited, commenced its operations. The company was honestly formed, with a *bonâ fide* capital, on which every share represents £20 cash. This, the writer considers, has direct bearing on the cost of producing electricity, because a company handicapped by watered stock, or exorbitant promoter salaries, has to pay interest on money it never had the use of.

The hydraulic plant consists of a main dam and power house, 1000ft. long, and a wing dam and guard pier 5000ft. long, forming a head race or basin with an average depth of 12ft. in low water. To secure this it was necessary to divert the waters of the St. Lawrence and lay bare the bed of the river for a distance of over a mile and remove over 400,000 cubic yards of rock.

The main dam is constructed of a series of isolated cut stone piers, with head gates and stop logs, furnishing in all thirty-six flumes and three waste weirs, and at the same time forming foundations for the power house and turbine sheds.

The total development will, when completed, consist of seventy-two vertical turbine wheels and twelve generators. The arc wheels connected in series of six, by gearing, to a horizontal shaft, at the end of which a generator is directly connected. The completed power house will contain twelve such sets.

Of the total installation forty-eight wheels are already in place, and the power house, head race, tail race, and dams are completed.

Each dynamo house will contain four three-phase general electric alternators, wound for 4400 volts at full load, and two direct-current exciters at 120 volts. There will be in the total installation three such dynamo houses, containing in all twelve dynamos and six exciters, each exciter being capable of exciting four machines. Each dynamo house will have its own switchboard, so arranged that each circuit may be operated from the switchboard of either power house. The floors are of slate and the buildings of brick. The current is generated at 4400 volts, avoiding the use of step-up transformers, is transmitted over bare copper wire on iron poles to the city of Montreal, a distance of about five miles, to the sub-stations, where the pressure will be lowered to 2300 volts, and by means of sub-station switchboards sub-divided into the desired units and distributed partly through underground conduits, and partly by overhead construction, throughout the city of Montreal and its suburbs, where we find a population of over 300,000 people offering a market for light and power. Of the total equipment one-third is already installed.

The wheels were tested at the Holyoke testing flume, on April 16th and 17th, 1897, and developed at full gate as follows:—With a speed of 76¼ revolutions, discharging 235·33 cubic feet of water per second and developing 300·84-horse power, showing an efficiency of 81·32 per cent., which would make the total possible output of our power house about 16,000 kilowatts.

Perhaps the greatest obstacle to a fair comparison of electric current produced by water power, as against the same current produced by steam, is the first cost. In the former case, especially if a large water power is to be developed, the expense of the whole installation, such as dams, head and tail races, &c., has usually been made at the commencement, while perhaps only a fraction of the power thus obtainable is at once used, therefore throwing a very much larger capital cost per unit than with a steam plant, which need only install the power necessary for immediate demand and continue increasing or adding thereto, as the demand therefor offers. In our own case you will notice it was necessary for us to spend about £200,000 in hydraulic development. This furnishes us over 20,000-horse power, whereas it will be some time before we will be able to convince the public of the advantages to be derived from the use of electricity. The 5000-horse power from a commercial point of view will have, for the present at least, to be charged with all the expense of the hydraulic development of over 20,000-horse power.

In estimating the cost of producing power from the Lachine Rapids the writer does not take into consideration the cost of distributing power, for this would be the same in either case, whether the prime mover was a water-wheel or a steam engine. He will therefore confine himself to the cost of developing water power and delivering that power on the bus-bar at the sub-station exclusive of the generator. He will add the cost of transmission line from the source of power to the sub-station in the city, because this is directly attributable to water-power plants, as it would not be necessary in the case of a steam plant, unless it were for transmitting power from a coal mine to a city, or following the practice laid down by the Brooklyn Edison Company, in locating their power house at a point convenient for obtaining coal and water at reduced prices, using high-tension transmission and converting by rotary converters at various sub-stations. There will also be included the step-down transformers to bring the pressure equal to that required for local distribution, namely, in the neighbourhood of 2000 volts. He will also charge the water power with a drop or loss in power from the rapids to the sub-station.

The writer therefore considers, in justice to the Lachine Rapids plant, it would be necessary to give, first the cost per kilowatt per year for the portion of the plant at present installed and connected to generators ready for operation, and, second, what the cost will be per kilowatt per year when the whole water power development is in operation. First, the total cost of water rights, dams, hydraulic machinery, power house, transmission line, step-down transformers, &c., is £191,440. Power developed 4000 kilowatts at the generator. Allowing 10 per cent. loss, there will be delivered at the sub-station bus-bar 3600 kilowatts, which is equivalent to £52 13s. per kilowatt capital cost.

	Per kilowatt. £ s. d.
This, at 6 per cent., would be equivalent to	3 4 0
Depreciation of £60,000, which will more than cover the cost of that portion of the plant subject to depreciation, rated at 5 per cent. and spread over 2000 kilowatts, would be equivalent to	0 17 4
Operating expenses, including labour, repairs, insurance amounts to £2055 per annum, which, divided into 3600 kilowatts, is equivalent to	0 12 0
Making a total cost per kilowatt on a twenty-four hour day basis, per year	£4 13 4

Second, the total cost per kilowatt with the whole water-power plant in operation. Before giving these figures the writer would like to explain that the figures herewith quoted are reliable for the cost of the completed plant, inasmuch as the same is at present under contract with reputable firms, the Lachine Rapids Hydraulic and Land Company having a limited time in which to complete the works ordered. The total capital cost with seventy-two wheels installed will be £222,653.

	Per kilowatt. £ s. d.
Power developed after deducting all loses will be 13,500 kilowatts at the sub-station bus-bar, equivalent to £16 10s. 4d. per horse-power capital cost, which, at 6 per cent, represents (per annum)	1 0 0
Depreciation per kilowatt will equal	0 7 9
Operating expenses, including labour, repairs, oil, and waste and insurance, if taken upon the same basis as already existing, will amount to £4091, equivalent to	0 6 4
Making a total for a twenty-four hour run per annum of	£1 13 3

It will be noticed that the operating expenses, as well as the depreciation per kilowatt, in the latter case is very much reduced; and it is a remarkable feature how constant our operating expenses are, even at present, being practically the same with full load as with no load. In connection with these figures it might be stated that coal used in Montreal and vicinity is what is known as Nova Scotian coal, and costs 14s. 6d. per ton for run of mine. The writer would also draw attention to the fact that the capital cost cited in each of the foregoing cases includes money paid for land of which the company owns over some eight million feet, fronting on the rapids, intended at some future date to form the site of a suburban town, and which it is hoped and expected will return the money expended in developing the water power above referred to.

* Abstract of a paper by Mr. W. McLea Walbank, presented at the annual meeting of the National Electric Light Association, held at Chicago, U.S.A., in June.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

THE last regular meeting of the Institute was held October 26th at the House of the American Society of Mechanical Engineers, New York City. Previous to the paper of the evening, the President, Dr. A. E. Kennelly, announced that the Committee of seven appointed by the Council to arrange for a co-operation between the Institute and the various colleges having testing laboratories had held its first meeting. This Committee was appointed with an idea of creating a closer relation between the Institute and the colleges, so that any engineering problems arising in the minds of the members which needed laboratory apparatus and work for their proper solution, could be given to advanced students at the various engineering colleges. A circular letter, giving a list of such problems, would in the near future be sent to the colleges, and it was hoped that all members would take advantage of this to submit all the problems that had occurred to them. They would then be forwarded to the various institutions, and when solved the solutions would be printed in the "Transactions" of the Institute, where they would be available to all. At the same time, the work could be printed in any other place.

Mr. A. A. Knudson then read a paper entitled "An Electrical Survey in the Borough of Manhattan, New York City." The discussion was limited almost entirely to a communication from Mr. William Maver, of the Empire City Subway Construction Company, New York City, which was read by the secretary, Mr. R. W. Pope. Mr. Maver had inquired of the managers of the various gas companies regarding electrolysis of gas mains, and had received the general reply that there were no indications of any such action. In connection with his work, he had examined many conduits and cables in the city, and could, as a result, say positively that there was no evidence, at least up to the present, of electrolytic action.

AN ELECTRIC RAILWAY IN SOUTH AMERICA.—A French company has secured the concession for the construction of an electric railway line connecting Cumana and Cumanacao in Venezuela. The length will be about 43½ miles, and the electrical power is to be generated by the waterfalls of mountain streams.

AN AMPERE BALANCE.

By Professor W. E. Ayrton, F.R.S., and Professor J. Viriamu Jones, F.R.S.*

The report of the Committee on Electrical Standards for 1897 ended with the following paragraph:—"It thus appears to be a matter of urgent importance that a redetermination of the electro-chemical equivalent of silver should be made, and that the general question of the absolute measurement of electric currents should be investigated. . . ." This work we were asked by the Committee to carry out, and a grant of £75 was voted in its aid. We were thus led to examine into the methods which had been employed by Lord Rayleigh, Professor Maseart, and others, for determining the absolute value of a current, as well as to consider some other methods which have not, as far as we know, been hitherto used.

After much consideration we decided to adopt a form of apparatus which, while generally resembling the type employed by some previous experimenters, possessed certain important differences; and, before expending any part of the grant of £75, to construct, without expense to the British Association, the following preliminary ampère balance:—

On a vertical cylinder about 17in. high and 6·8in. in diameter we wound two coils, about 5in. in height, separated by an axial distance of 5in. The coils consisted each of a single layer of about 170 convolutions of wire, and were wound in opposite directions. From the beam of a balance there was suspended, inside this cylinder, a light bobbin, about 4in. in diameter, on which was wound a coil about 10in. long, consisting of a single layer of 360 convolutions, and the whole apparatus was so adjusted that when the beam of the balance was horizontal the inner and outer coils were co-axial, and the top and bottom of the inner suspended coil were respectively in the mean planes of the outer stationary coils.

This arrangement was adopted because with coils consisting of only one layer the geometrical dimensions could be accurately determined, and because the shapes of the coils lent themselves to the use of the convenient formula, readily expressible in elliptic integrals, for the force F, between a uniform cylindrical current sheet and a co-axial helix, viz.:—

$$F = \gamma\gamma_h (M_1 - M_2).$$

Where γ is the current per unit length of the current sheet, γ_h the current in the helix, and M_1 and M_2 the coefficients of mutual induction of the helix and the circular ends of the current sheet.†

The value of a particular current of about 0·63 ampère having been determined absolutely by means of this apparatus, the rate at which it would deposit silver under specified conditions was ascertained indirectly by observing its silver value on a Kelvin balance which had been kept screwed down in a fixed position for several years past, and which had been calibrated many times during that period by reference to the silver voltameter.

The result of this preliminary investigation showed that the silver value of the true ampère was so nearly equal to the reputed value, viz., 1·118 milligramme per second, as to require the use of an apparatus still more perfectly constructed, and therefore of a much more expensive character, to enable the error, if any, in this value to be ascertained with accuracy.

We, therefore, started on the design of the instrument, of which we now submit the working drawings, and for the future construction of which we would ask for a grant of £300, including the unexpended grant of £75 voted last year.‡ And we anticipate that this new piece of apparatus may prove worthy of constituting a national ampère balance, the counterpoise weight for which will be determined purely by calculation based on the dimensions of the instrument, the number of convolutions of wire in the three coils, and the value of the acceleration of gravity at the place where the instrument may be permanently set up. In this particular it will differ entirely from the Board of Trade "Ampère Standard Verified, 1894," which has had its counterpoise weight adjusted so that the beam is horizontal when a current passes through the instrument, which will deposit exactly 1·118 milligramme of silver per second under specified conditions. In fact, the proposed ampère balance and the existing ampère standard will differ exactly in the same way as do a Lorenz apparatus and the Board of Trade "Ohm Standard Verified, 1894."

We have to express our thanks to Mr. Mather for taking charge of the construction and use of the preliminary apparatus; for checking all the calculations in connection with the determination of the electro-chemical equivalent of silver that was made with it, as well as for superintending the making of the working drawings of the new ampère balance. We have also to thank Messrs. W. H. Derriman and W. N. Wilson, two of the students of the City and Guilds Central Technical College, for their cordial assistance in carrying out the work.

* Read before the British Association, Bristol.

† "Proceedings" of the Royal Society, vol. lxiii., "On the Calculation of the Coefficient of Mutual Induction of a Circle and Co-axial Helix, and of the Electro-magnetic Force between a Helical Current and a Uniform Co-axial Circu-cylindrical Current-Sheet." By Prof. J. V. Jones.

‡ This grant of £300 has since been made.

THE WORKS OF THE MOTHERWELL BRIDGE-BUILDING COMPANY.

The works of this company, which has been recently established to carry on bridge building, roofing, girder, and all kinds of structural iron and steel work, are situated alongside the Caledonian Railway, a short distance from Motherwell Station, and possess ready and excellent siding access to the main line. They are embraced under one roof, whose loftiness and breadth form a conspicuous feature alongside other and less uncommon surroundings. The main portion of the roof is one span of 150ft., arched to an easy radius, and supported on vertical sides extending down to about mid-height, at which point are sloping lean-to extensions on each side, measuring 30ft. each. The total width of the building is thus 210ft., while in length it is 250ft., and in height 42ft. at centre of span—dimensions which are more suggestive of large modern railway termini than of works for the preparation of structural iron and steel.

There are four main rows of columns from end to end of the building, dividing the main portion into three bays or sections of 50ft. width each. The centre bay is reserved entirely for erecting, and the two side bays for machining purposes, while the lean-to bays at either side are occupied with smiths' hearths, hydraulic presses, and other machinery. The columns are all of cast iron, and are spaced at close intervals, and carry wrought steel girders at heights to suit the travelling cranes which serve each bay. The roof trusses are of timber, of the light yet strong "Belfast" construction, closely pitched, supporting corrugated iron roofing. There is no glass on the roof, all the light—and it is most copious—being received through the sides above the lean-to portions, and through the ends of the building, glass in these portions occupying all the area.

The spacious interior markedly exhibits the recognised desiderata for premises in which constructional ironwork can be efficiently carried on, viz., clear and ample floor space, good light and good head-room; also easily-manipulated lifting and transporting appliances. A 25-ton overhead crane, by Messrs. Chaplin and Co., Glasgow, serves the centre or erecting bay, the clear height below crane being about 34ft. A 10-ton overhead crane serves one of the side bays, while the other has a line of rails the full length, traversing which and the rails in the outside yard is a powerful locomotive jib crane. This and the smaller overhead cranes are by Messrs. Marshall, Fleming, and Jack, of Motherwell. The overhead travelling cranes, as well as most of the machine tools, are actuated by electric power; this system of driving, in fact, being adopted throughout, except, of course, in the case of the riveting appliances and flanging presses, where hydraulic power is employed. The generating plant, and the motors driving the various machine tools—in fact, the whole electric installation, including the arc and incandescent lighting arrangements—has been supplied and fitted by the Paterson and Cooper Company.

The dynamos are belt-driven from an engine of the marine type, supplied by Messrs. Duncan Stewart and Co., of London-road Ironworks, Glasgow, who are also responsible for the hydraulic pumping engines, and most of the plant throughout the premises actuated by hydraulic power. Notable items of this description are two hydraulic flanging presses for angle-knee bending and joggling purposes, and as many as six presses of a special kind for use in the construction of iron trough flooring from the flat plate. These are ranged in line in front of a heating furnace situated near the boiler-house and base of the chimney stalk. The installation of drilling machines is very extensive, there being two rows of drills, twenty in each row, all of the radial-arm type. These are all by Messrs. Duncan Stewart and Co., Glasgow. Conspicuous among others of the heavier machine tools are heavy punching and shearing machines by James Bennie and Co., heavy plate rolls and flattening rolls, and also several plate-edge planing machines, all by Messrs. Littlejohn and Service, Johnstone. The drawing-office and template-making department are excellently arranged and lighted, and altogether the works are thoroughly representative of what is most modern and capable in the branches of industry they have been designed to overtake.

ELECTRIC DUMB WAITERS.

The new public library at Chicago is equipped with a system of dumb waiters for delivering books from one department to another. These devices are described in the *Electrical Engineer*, New York; they are operated by electric motors. The system is that of the Burdett-Rowntree Manufacturing Company, of Chicago. Most of these waiters travel simply in a vertical direction like an elevator, though some have recently been put in that travel in a variety of angles. The vertical dumb waiters for transferring books from one floor to another are controlled from any floor by the movement of a pointer. At each floor is a pointer on a semicircular dial. The pointers on all the floors are connected together mechanically, so that if one of them is moved, all move. These pointers are intended to be moved by hand. The dumb waiter will come to whatever floor the pointer is placed at. If an attendant on the fifth floor wants the waiter at his floor, he moves the pointer to 5, and if all is right the waiter comes to his floor. If he wants to send it to the first floor, he moves the pointer to 1, and so on. To avoid confusion and accidents the controller of the waiter motor is always locked when any door to waiter shaft is open, so that the waiter can never be started when an attendant has the door open and is not expecting the waiter to start.

The motors are arranged so as to avoid the necessity of counter-weights and ensure a reasonably constant speed for the book trays. The motors are series wound, about 1-horse power, and run at the rate of about 500 revolutions per minute. Being of such small power and low speed, no starting resistance is used with them, but the current is snapped on at full voltage. In order to prevent these motors from running away with the car going down heavily loaded, part of the current is shunted around the armature through a resistance. This has the effect of so increasing the field strength by the greater volume of current passing through the fields that the counter electromotive force of the motor is very high for a given speed, and little current can flow through the motor. When the waiter is going up the connections are altered, so that part of the current is shunted by a resistance around the fields, which has the effect of weakening the field strength of the motor, reducing the counter electromotive force at a given speed, and permitting the motor to run faster than with full field strength. Of course, the resistance with which the armature is shunted is much higher than that used on the fields. The practical result of this electrical arrangement of the motor circuits is that the maximum variation in the time of ascent and descent of the waiter is only one second above or below an average of 17 seconds, or a variation between 16 and 18 seconds.

Electrical Machinery in Prussia in 1898.—The following particulars are from a memorandum by the Commercial Attaché to H.M. Embassy at Berlin printed in the *Board of Trade Journal*:—"Every year the increase of electrical plant is becoming more marked in Prussia; and although there are no complete statistics on the subject, a good idea of the advance that has been made is to be obtained from the data which exist as to electrical driving machinery, for this is chiefly driven by steam, and is, therefore, to be found in statistics. The latest returns for the beginning of 1898 are to be found in the following statement, which includes all State and private undertakings in Prussia, with the exception of those under the War-office and Admiralty. Of machines driving dynamos, there were in 1891, 983 with a horse-power of 49,489, whereas by 1898 this number had risen to 3305 of 259,726-horse power. In the former year there were 794 machines exclusively used for driving dynamos, while 189 were only partially used for this purpose. In the latter year there were 2490 used exclusively used for driving dynamos, while 815 were only partially used for this purpose. The increases hear shown are enormous. It is worth noticing the great development since 1897. In that year the total horse-power was 191,032 only, whereas by 1898 it had risen to 258,726. During this interval of one year the number of machines had increased from 2837 to 3305.

GENERAL DISTRIBUTION FROM CENTRAL STATIONS BY ALTERNATING CURRENTS.*

Ever since the installation of the first few pioneer alternating-current central stations, just ten years ago, we have heard it predicted with persistent reiteration that for the distribution of current for lighting from central stations direct current was a thing of the past, and that in a few years the alternating-current transformer system would hold the field without a competitor. To many, this prediction may seem to have been fulfilled, considering the enormous number of alternating-current plants, compared with direct-current, that have been installed, and the remarkable impetus given to electrical industries by the development of alternating currents. The great success achieved in the transmission of power by polyphase alternating currents in the last three years, has but strengthened this general belief, and left fewer champions to adhere to the direct-current cause. These great achievements, I say, have led the enthusiast to think all progress confined to alternating systems of distribution. Deeper investigation, however, shows that while in point of number the alternating-current stations, reaching into the thousands, completely overshadow those of direct-current, there are few really large stations, outside of water-power plants, that are to-day employing alternating currents for distribution, and that while enormous investments have been made in direct-current stations in our larger cities, comparatively small amounts have been invested in alternating-current work.

The alternating system was heralded as providing a means of distribution with a great reduction in first cost of plant, and for years the development of the system has been made with this the principal end in view. On the other hand, direct-current distribution in the form of the Edison three-wire system has been steadily and intelligently developed to the highest standard of economy of operation, simplicity, and permanence. In the same city, alternating-current stations have not, as a rule, been successful in competition with three-wire stations; their service has not been as good, and their profits have been smaller. I may startle many by stating frankly the discouraging fact, which has been barely whispered at times, that, judged by the standards of the magnificent Edison properties in many of our larger cities, few alternating-current central stations in the United States have been a success. This damaging admission, however, is not an indication of any loss of faith on the part of one who has been identified with alternating-current work since its early days. Far from it. The fault lies, not with the alternating current itself, but with its application. Its few apparently inherent deficiences, such as the difficulties of operating motors and arc lamps, have been overcome, and can therefore hardly be held responsible for the difference in the commercial results obtained with the two systems.

As I have said, the ends in view in the development of the two systems have been radically different. The one was to produce a given amount of light for the minimum of investment; the other was to provide a permanent investment that would render the maximum of profit. These standpoints in general mark the difference between the manufacturer and the user, and we find these two systems developed in this way—one almost entirely by the manufacturer, and the other by the combined efforts of the various users. The results are the natural effects of progression along these lines.

The early alternating-current stations were installed on the principle that the drop in lines with distribution at 1000 volts was so small that it was practically negligible. Two wires were accordingly run out from the station, passing along those streets where light was to be furnished, and lights were connected *ad libitum* at any desired points between the station and the farthest end, without reference to such trifling considerations as differences in potential. Distribution was attempted in this way for years, and in many places is still in operation. Lines are even being constructed to-day without any notion of a system of feeders and mains, although an almost perfect system for the maintenance of uniform pressure was in operation in many Edison stations before the first alternating station was in existence. Fortunately for the operators of such models of simplicity, the current delivered has usually been so small in quantity that with the proverbial No. 6 wire, which seemed to possess virtues not affected by distances, the difference of pressure between neighbouring customers rarely exceeded 10 per cent.

One alternating-current station of which I have intimate knowledge has used pressure wires in connection with each feeder for years. There may be a few others, but they are rare exceptions, even to-day. The usual system of distribution provides a separate transformer for each customer. In many cases this implies the use of a very small transformer. It is impossible to make the efficiency of small transformers high. As each customer may at times use all of his lamps, he must have full transformer capacity for such an emergency. The ordinary ratio between maximum station loads and the number of lamps connected, is in most cases under 50 per cent. where meters are employed. The transformers then, being of a total capacity equal to the number of lamps connected, average at best only 50 per cent. of their rated capacity at the maximum station load. In most stations the average load generated is much less than 25 per cent. at the maximum load, and therefore with twice the transformer capacity of that represented by maximum station load, the average transformer load would not exceed 10 per cent. of the transformer capacity, all the year round.

The efficiency of the average modern transformer of usual size at 10 per cent. of its rated load is not over 65 per cent., and the average of transformers at present in use not more than 50 per cent. It is perfectly safe to say that there is not an alternating-current station to-day using individual transformers for each or neighbouring customers that can show an average efficiency of distribution of over 60 per cent., and few that can show over 50 per cent. In Europe, it is to some extent the practice to use transformer sub-stations with low-potential distribution from these points. Transformers are cut in and out at these sub-stations by attendants according to the demand for current. It is doubtful if, after paying interest on the investment in property and housing for these transformer stations, together with the investment in instruments and switches required, and the attendants' wages, there is very much saving effected. Had we nothing better to turn to than these systems, the cost of distribution from large stations would be extreme compared with the direct-current Edison three-wire system, and competition with the latter could not be a success.

Another very important consideration is the economy or efficiency of lamps used. To employ successfully the highest-economy lamp made, a very uniform pressure must be maintained. With the usual alternating-current system, and with an equally good disposition of feeders and mains, the variations of pressure will exceed those in a direct-current system by nearly 3 per cent., on account of the transformer drop, and to secure even this limit of variation pressure wires must be used with each feeder. It is not suprising to find, therefore, that almost all alternating-current stations are using lamps requiring 20 per cent. more current than those used by direct-current stations.

On examining the plans of the system of distribution of a direct-current system we see a remarkable network of feeders and mains most carefully calculated for the maintenance of uniform pressure. Means for regulating more or less independently the pressure on each feeder are provided. From numerous points in the system corresponding to the feeder terminals, pressure wires are brought to the station, and indicators show the pressure at all these points. Numerous devices and appliances are shown us which must have been the result of years of experience in the development of distribution methods. But let us look a little further. What are those

* Abstract of a paper by Herbert A. Wagner, presented at the annual meeting of the National Electric Light Association, held at Chicago, U.S.A., in June.

massive beams? They do not seem to support anything. "Those are not beams. They are copper wires to carry the current out," we are told. They are necessary with this system, but a very serious drawback, it would seem. Another question troubles us — Why occupy ground in a part of the city where property must be very valuable? Because the plant must be near the centre of business. If it were twice as far away, four times the amount of copper would be required in those bars.

If this necessity for using such an enormous amount of copper is the weak point of a beautifully-developed system, why do we not endeavour to overcome that particular point and adopt the rest, instead of starting out anew and alone to develope another system from beginning to end? At the present time the Edison three-wire system of distribution is the most efficient in use, and the most nearly perfect in details. The usual system employed with alternating current is not efficient, and does not admit of as close regulation, but it is vastly cheaper to install.

Comparing the cost of individual transformers and high-potential distributing mains with the three-wire system of mains at low potential, we do not find a great difference in first cost in favour of the alternating. We do find, however, that the Edison feeders for the same distance cost about thirty-one times as much as for alternating current at 1100 volts, 125 times as much at 2200 volts, or 500 times as much as at 4400 volts. It would then appear that if we could apply alternating current to the feeders at high potential and transform down for the mains, we might reach the lower first cost of the ordinary alternating-current system, and possibly retain all the best features of the direct current. To accomplish the former the transformers must be provided at a small proportion of the cost of the alternating-current feeder, and to do the latter they must not increase the average losses in the system. It is obvious that we could with alternating current move our station to any reasonable distance from our centre of distribution, and at comparatively small additional cost for feeders. The whole problem then seems to come down to transformer efficiency and means of regulation.

To consider the matter of regulation first. We see at a glance that we cannot use the direct-current method of regulation by supplementary bus bars, but we can use the booster method, and can, moreover, apply a static booster to each feeder to regulate within any desired limits and with as small gradations as necessary. In fact, the booster method of regulation was first applied to alternating-current distribution, and operates with much less average consumption of energy than either the supplementary bus or direct-current booster method. In this important consideration, we can therefore improve on and simplify direct-current methods.

The means of regulation having been in this way provided for the feeders, it remains to be considered what we shall do to eliminate the effects of transformer drop. As we have determined on a secondary low-potential three-wire distributing system of mains, we can altogether dispense with high-potential mains, and limit the high potential to the feeders. If we do this we can conveniently have the transformers of the same unit capacity as the feeders, and arrange each with its primary connected to its independent feeder, and its secondary feeding into the three-wire mains. We know that the effects of our feeder drop are eliminated if we regulate by pressure wires from the feeder ends. In the same way the effect of our transformer drop may be eliminated by bringing pressure wires from the secondary terminals. The feeder drop and transformer drop therefore become one, and are cared for in the same way. We can even secure better general regulation than with the direct-current system, as we have a better form of feeder regulator, and have eliminated the effects of transformer drop.

Now, to return to the transformer itself and its efficiency. It is evident that with this system the transformer capacity need be no greater than that required for maximum station load, instead of more than twice that amount, or nearly equal to that required for the total number of lamps connected. This at once doubles the average load on our transformers, and raises the average efficiency. It also incidentally reduces the first cost of transformers in still greater proportion. We also know, however, that transformer efficiency at light loads is dependent on the iron loss, and that this is interdependent with the regulation or drop. If we can increase the drop we can decrease the iron loss, and thereby greatly increase the average efficiency. Having provided against any interference with the regulation of the system by the transformer drop, we can afford to increase that to the heating limit of the copper. In this way a 100-kilowatt transformer can be built with an average efficiency of over 98 per cent. The entire transformer loss can, moreover, be more than made up by the less loss in feeders which we would naturally have with alternating current.

We have thus eliminated the two features in which the ordinary alternating-current system of distribution has been inferior to the direct-current, and have provided means for obtaining better regulation and higher efficiency at a very much less cost of installation than with the direct-current system. This system was conceived several years ago, and it has since been my good fortune to have an opportunity to install a system of this kind on a large scale, which is now in very satisfactory operation. It is laid out exactly as a three-wire Edison system would be, except that there are no sub-feeders. A network of mains is planned as if for use with direct current. The feeders are all designed for 110-kilowatt maximum load at 1100 volts, and at each feeder end is placed a 110-kilowatt transformer feeding into the three-wire network in the same manner and at the same points as with the direct-current system. The transformers are located in manholes of suitable design. From the secondary terminals of each transformer pressure wires are run back to the station. Each feeder has an independent regulator, by which the pressure can be raised or lowered. There are no primary mains, nor any connection whatever between the primary feeders. The regulators perform two functions. They are used to maintain the proper pressure as indicated by the volt meters, and also to divide the load between transformers in any way desired as indicated by the feeder ammeters. It is possible to shift the entire load from one transformer and feeder to an adjacent transformer in this way without sensibly affecting the pressure on the system, and an equal division of load between transformers can be readily maintained at all times if desired. This is a very important consideration when very heavy loads or overloads are to be carried. The distribution of load on any large system is constantly changing as new customers are connected, and in large Edison stations certain feeders often become so overloaded that it is found necessary for their safety to put resistance in series with them to force some of the current to other feeders. The possibility of overloading any individual feeder beyond its share is absolutely provided against in the system described. To make the arrangement of this system perfectly clear it is illustrated diagrammatically in Fig. 1.

It has been the practice in some European stations to cut out transformers during periods of light load, but it will be seen that cutting out transformers in the system described would only decrease the efficiency; in fact, the efficiency is higher at about the average load, and the system was designed throughout to accomplish this result.

Several large three-wire direct-current Edison stations are beginning to employ alternating current to extend their lighting territory beyond that possible or profitable with low-tension current. This is a recognition of alternating current which would not have been considered for a moment a few years ago. They now propose to use alternating current to transmit their energy at high potential to a distant sub-station, where it will be transformed to a lower pressure and then again transformed by means of rotary transformers to direct current, which is in turn distributed over the three-wire Edison system as if generated in the ordinary way.

The loss in the conversion to alternating current and back is about 15 per cent. in addition to the loss in static transformers and lines. This distribution might be accomplished without the additional machinery, wire, real estate, labour, and loss in efficiency.

A much higher efficiency of distribution and better regulation could be secured by using the alternating-current system as it is, without transformation to direct current, and everything could be controlled from the main station without employing labour or apparatus at sub-stations.

It seems now to be the universal opinion among advocates of direct current that the enclosed-arc long-burning lamp is destined to replace all the old forms of arc lamp. Equally good lamps of this type are now made for alternating current. They are also about as free from noise as the direct-current lamps.

The greatest argument used against alternating current used to be that it would not run a motor. It has long ago proved that it can, and that without a commutator. This subject now brings us to multi-phase systems. There are two of these systems in general use, the two-phase and the three-phase. Other systems are but

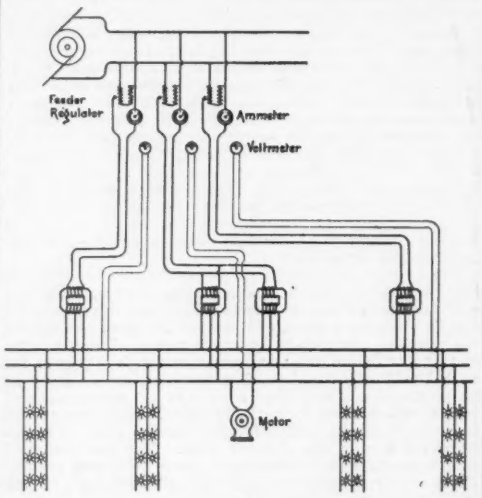


Fig. 1—SINGLE PHASE ALTERNATING-CURRENT SYSTEM
With High-pressure Feeders and Low-pressure Distribution—Independent Feeder for each Transformer or Group

modifications of these, and will be mentioned as such. Motors can be operated with equal facility and efficiency on either system, and have many distinct advantages over direct-current motors. For long-distance power transmission the three-phase system shows an economy in copper, but for lighting, or for lighting and power combined, it is not at all well suited. I might say that where lighting is a distinct feature and first-class service is to be rendered from a large station, the three-phase system cannot be used successfully.

For good regulation and simplicity, the single-phase system cannot be equalled by any multiphase system. The so-called monocyclic system is a modified two-phase system in which current is distributed for lighting on a single-phase circuit only, and a third wire carries current in quadrature to the first, which, in connection with the first, is transformed to a three-phase relation wherever it is desired to operate motors. The regulation of this system can be made almost as good for lighting as the single-phase, and can be as simply effected. The third wire adds complication, but no

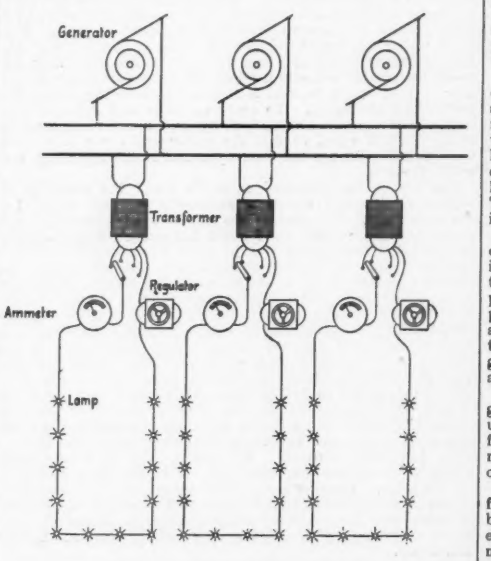


Fig. 2—ALTERNATING CURRENT SERIES ARC-LIGHT SYSTEM

balancing is required, as all the lighting is done from single phase on two wires. If low-tension three-wire distribution is attempted with this system, a fourth wire must be used for power distribution.

The use of storage batteries is the direct-current advocate's last and greatest stronghold. We may ask first whether storage batteries have yet been proved to be a valuable adjunct to the central station, cost and maintenance considered. It is true that they are being tried by several large stations, and we watch eagerly for the results. They equalise the station load to a greater or less degree, and cut down the generator capacity for the peak. Are they, however, cheaper than generators, engines, and boilers of the same capacity? Are the losses in transformation less than the cost of a few more attendants? Is their maintenance less expensive than that of generating apparatus? These questions cannot as yet be answered in the affirmative.

Before closing I wish to draw your attention more forcibly to the flexibility of the alternating-current system. We all know of the many applications to which this current is now put. The use of the rotary transformer has been widely talked of and described for the last two years. The facility of operating lines at any potential desired, through the means of step-up and down transformers, is no longer an experiment. Multiphase motors are familiar to all, while single-phase motors have been much talked of and written about, and failures have, time and again, followed boasted success. Many of us, however, have within the last year seen them quietly at work, thoroughly tamed and domesticated. One large station is using them extensively, and is so thoroughly convinced of their success that it has discarded all notion of using multiphase distribution, although it is using generators that can be operated two-phase if desired. Direct-current motors are being rapidly replaced by these single-phase motors to secure uniformity of system.

Arc lamps have been familiar to us on alternating-current circuits for some time, and the alternating-current enclosed long-burning arcs are now numbered by the thousands. Street lighting is still, however, in most places done on the direct-current series system, and even the largest machines yet built for this purpose are very small in comparison with our large direct-connected generators.

The great desideratum in central station practice is to be able to employ one system for everything. All current for all classes of service should be supplied from but one type of generator, be this direct current or alternating current. In this way only can the maximum output be accomplished from a given investment in machinery and apparatus, and the greatest economy in operation secured. This has been accomplished in many stations where a limited range of service is to be provided. Arc lighting has, of all, been the most troublesome to provide for. How shall we operate our arc lamps from our incandescent lighting system, has been the anxious inquiry. The constant-potential arc lamp has answered this question for commercial lighting, but city street lighting cannot be so easily provided for. The Edison companies have done a limited amount of this from their three-wire system, but this can be done to advantage only in districts where mains have been provided for commercial lighting. For extended arc lighting the small series machine with its belts and clutch pulleys still holds the fort.

I am able to state, however, that one large company has recently solved the problem to its entire satisfaction. This company furnishes 2600 street lamps to the city, lighting some 300 miles of street. These were operated by a small army of series arc machines. They were installed by a company that was acquired by purchase by the one first mentioned. As this company had long since adopted alternating current for its entire distribution, it was extremely desirable to be able to operate these city lamps from its large direct-connected alternators, thereby saving in fuel, attendance, floor space, and reserve investment.

After a few months' trial of an experimental circuit with alternating current, it was found perfectly feasible to operate the same direct-current lamps, slightly re-modelled, on the same circuits of sixty or eighty lamps in series. A system of this kind was therefore adopted, and the company now has 2300 of these lamps in regular operation by alternating current in this way. The circuits are each provided at the station with a regular step-up transformer of a maximum capacity of 4000 volts and ten amperes, and the feeders to these transformers are treated on the switchboard in the same way as the feeders for incandescent lighting. It is quite usual for one generator to carry 2000 of these lamps. The lighting is satisfactory to the city, and the lamps give better service than when operated by direct current. There has been a very marked saving in fuel and attendance. The indicated horse-power per arc lamp is considerably less than with the direct-current arc lamps operated in the usual manner. Fig. 2 shows this system in diagram.

In summing up, we find the following marked features in which the alternating current, properly installed, has been shown to have pronounced superiority over the direct current:—Highest possible efficiency of distribution and operation; best regulation; largest territory desired readily supplied from one station; comparatively small cost of feeders, effecting enormous saving in investment; least cost of real estate; cost of installing and operating sub-stations entirely avoided; the only system in which all classes of service can be supplied from one type of generator; greatest flexibility.

NEW YORK ELECTRICAL SOCIETY.

THE hundred and ninetieth regular meeting of this Society was held on October 27th, at the Pearl-street Station of the Brooklyn Edison Electric Illuminating Company. The meeting was largely attended, and the total number—some 175—was divided into parties, which, under the guidance of men from the Edison Company, made the round.

The Pearl-street Station, the first inspected, was designed and erected in 1889, with a capacity of 3000-horse power. It has since been enlarged, and now has 5000-horse power, with an ultimate capacity of 15,000-horse power. Except at maximum load, this station is supplied from the Union Station, which was visited later, with three-phase current at 6000 volts. This is stepped down, and transformed by means of rotary converters to direct low-tension current, for use upon the Edison three-wire mains. The entire party next proceeded to the great Bay Ridge Station, it is said the most remarkable in the United States.

The present building, designed to contain 15,000-horse power, is only one quarter the contemplated size of the final plant, which, it is expected, will be 60,000-horse power. At present there are only two units installed. These consist of a Hamilton-Corliss 1500-horse power engine connected to a 1000 kilowatt general electric three-phase generator, furnishing, at full load, current at 6600 volts, and a 3000-horse power McIntosh, Seymour, and Co. tandem twin compound horizontal side-crank engine, and a 2000 kilowatt general electric three-phase generator, stationary armature type, also of 6600 volts.

Current from these generators passes to the switchboard on a gallery at one end of the immense engine-room, thence out on the underground cables to the various sub-stations, where it is transformed by rotary converters or induction motors, driving arc machines into the proper current for lighting either incandescent or arc lamps.

One of the sub-stations, Station A, was next visited. This was formerly a steam plant. It is now a combination of storage batteries and arc light machines driven by 100-kilowatt general electric induction motors, directly on the 6000-volt circuits, each motor driving two 120-lamp Brush machines, or twenty-four machines in all. This battery plant has 14,000 ampère hours' capacity, with regulating end switches, which are used in charging or discharging to adjust the voltage.

A NEW ZEALAND ELECTRICAL INSTALLATION.—In the Otago district of New Zealand there are a number of electric power installations in connection with reefing work, and there has also been installed a large dredger worked by electricity, says the *Western Electrician*. Most of the steam dredgers used in this extensive district carry an electric lighting plant. At the present time more than one hundred dredgers are at work in Otago Province alone, and nearly all are conveniently situated for coal supply. In some parts of the province coal is very cheap at the pit's mouth, but outside of the neighbourhood of the coal pits, coal is extremely dear. At Queenstown £7 per ton is paid for household coal, £6 of which is paid for freight for the last thirty miles of the distance covered; 17s. 6d. per 2001b. is paid for smithy coal. Freight rates are excessive. During the last twelve months there has been a large increase in the number of dredgers at work, and in most instances the results have proved very satisfactory, the dredger known as "Electric No. 1," on the Molyneaux, having obtained as much as 658 ounces of gold in five days, and, according to later reports, the average return of the dredgers per week has been little short of 100 ounces.

HIGH-TENSION TRUNK MAINS.

THE London Electric Supply Corporation may be said to have been the first users of trunk mains, within the meaning which we now attach to that term, and the overhead system which carried current at a pressure of over 2000 volts from the original station of that corporation now situated in Bond-street, consisted of single conductors, which were insulated with india-rubber, and were generally suspended from poles erected upon the roofs of the houses in the district then to be lighted. The arrangement, as we now look upon it, was one of danger and full of imperfection; and when Mr. Ferranti, who was then the engineer-in-chief to that company, and who may be said to have been half a generation before his time in the conception of running alternating-current machines at a potential of upwards of 10,000 volts, put down the great central station at Deptford, he was compelled to look inward for some idea of conductor which should safely and suitably carry current at that then practically unknown pressure over the seven miles and more which separated the central and the distributing stations of the new system. He had no experience to guide and govern him, and no friendly contractor who was ready to undertake to construct a main, and for these reasons he was obliged to look inwards into his own mind, and to work towards the end that he should arrive at something capable of carrying the output from the station on the banks of the river to the West End of London without breakdown or failure of any kind. In the result he got out what has been known as the Ferranti Trunk Main; but as things were marching with much rapidity in the affairs of the corporation—for the machines installed at the Grosvenor were approaching an overloaded condition in 1888—and as it became necessary, owing to a multitude of causes, that the engineers of the London Company should construct their own main, and therefore design, build, and put down special and heavy plant for its manufacture, involving many delays, preparations had to be made to run pairs of india-rubber single conductors on poles overhead all the way from Deptford; but though the poles had been made, and wayleaves obtained, some experimental running proved that the drawbacks of imperfect insulation, induction, danger to life, &c., were so serious that the scheme had to be abandoned. The manufacture of the Ferranti Main was still delayed in its starting, and the Fowler-Waring Cable Company, perhaps rashly, but with confidence, undertook to construct a concentric lead-covered jute cable, which should be in every way satisfactory for the pressure to be used. So confident were they of success, and so infectious was their confidence, that for a time operations were suspended on the Ferranti Main, and all the energies of the the Fowler-Waring Company, and of the engineering staff of the London Electric Supply Corporation, were devoted to the laying down of two mains of ¼in. section along the parapet of the South-Eastern Railway, over Charing Cross Bridge, and so to Bond-street. But, alas, when all had been finished, and the high-pressure put upon the cable, it was found that the insulation was insufficient, that it broke down, and that running thereon as intended was an impossibility. An experiment was then made of using the two concentric conductors as single mains, but at a reduced pressure, one cable taking the current to London, the other acting as return to Deptford; but so grievous did the loss prove to be, and so alarming were the induction effects, particularly when a fault occurred—by no means a rarity—upon the signalling system of the South-Eastern Railway, and upon the telephones and telegraphs of this and neighbouring kingdoms, that it became necessary to write down the Fowler-Waring cable as a failure, to admit that all the confidence in it had been misplaced, and for Mr. Ferranti and his staff to turn once more to the construction of his own main.

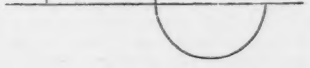
The loss on the original Fowler-Waring system of cables, due partly to their own imperfections, partly to the fact that the "go" and "return" was effected through quite distinct single cables, and partly to the fact that the machines were generating at a much lower potential than that for which they were designed, amounted to a good round 55 to 60 per cent. between Deptford and the receiving station in Bond-street. It was found necessary to run the machines at a pressure of between 7000 and 8000 volts at one end to secure the reception into the transformers at the other end of current having an electromotive force of 5000 volts. Such a loss as this, though very serious, would not have been fatal to the cable system then adopted, for it only fell upon the shareholders of the London Electric Supply Corporation; but the Postmaster-General, the directors of the South-Eastern Railway, and the public at large had to be reckoned with, and when it became an accomplished fact that as soon as the 1000-kilowatt machines at Deptford were started, the telephones all over the metropolis were rendered useless, because of the induction "roar" set up, the telegraph instruments were so affected that even an operator in Rome could keep the log of the starting and stopping of the alternators, and when a fault occurred the signals on the South-Eastern Railway were dropped, then the time came for the "scrapping" of the Fowler-Waring cable. But some running had been done before all these effects had been demonstrated. Some mechanical failures of plant at the central station had arisen, and had to be dealt with, and so the Grosvenor supply station was obliged to run overloaded, as its machinery had become for many months beyond the time when it should have had its sorely-needed rest.

In the meantime, however, plant had been ordered and erected at Deptford for the construction of the new main, and relay gangs of men were working day and night, on week days and holidays, to turn it out, and all the experience obtained with the Fowler-Waring cable was utilised to the full. It was evident that the new main should be of concentric design and construction, for the inductive effects had to be overcome, and Mr. Ferranti, being original, determined to make his main of copper tubes disposed accordingly. The insulation, arranged to cover the inner tube, and capable of safely withstanding a piercing effort of well over 10,000 volts, was composed of paper which had been saturated in a solution of black earth wax, and which was wound on to the inner conductor by means of a long machine, provided with chucks at either end to hold the tube, a bath of hot wax, and a broad table for the manipulation of the paper. As soon as the required thickness of insulation had been wrapped on to the tube it was taken out of the machine, and slipped into another tube of equal sectional area, but much larger diameter, which formed the outer couductor. The whole main was then drawn through a die, which, while elongating the outer tube, drew it firmly and solidly down on to the insulation. It was not Mr. Ferranti's original idea to erect the main in its then condition, the outer being earthed in its whole length, but it was found upon testing a length of bent main that the current preferred to jump across the short cut rather than stick to the outer copper circuit; and as the difference in potential between the town and the central station ends amounted to some few hundreds of volts, it became evident that the outer must be insulated to save any recurrence of the telephone and telegraph troubles; so the main with the outer copper tube drawn down was again placed in the machine to receive a few more turns of paper insulation on the outer part, and the whole was then covered with an iron case to secure mechanical protection. The selection of paper treated as we have described for insulation was in all probability made by the inventor owing to the mechanical advantages which he foresaw it would possess on account of the great number of laminations combined in half an inch thickness of insulation, and it is unlikely that its capacity advantages as a dielectric were then anticipated. Of this we shall say more presently.

From an electrical point of view, paper as an insulator has proved that it possesses many advantages over any other known fibrous material in its resistance to pressure, which is doubtless attributable to the fact that the fibres, although probably similar in their composition to those found in jute and cotton, are better felted or matted together, and are thus able to resist pressure to a much greater degree, while it is further obvious that any one of the wrappings of a paper cable may be faulty at a particular spot without in any way impairing its general safety.

Each length of main so made was about 17ft. 6in. long, the necessities of manufacture imposing a limit in length, and the mains thus constructed were joined together by means of a short copper rod in the inner, and a copper sleeve on the outer tubes, the insulation being made as far as possible homogeneous in its continuity by being coned male and female where joined. This trunk main was put down during the autumn and winter of 1890 and the spring of 1891, and some of it remains to this day, doing efficient service. That there should have been many faults or breakdowns with such a cable might have been expected, its resistance to bending, and the vulnerability of its multitude of joints, the difficulties experienced owing to expansion and contraction, to the corrosion and deterioration of its outer covering of iron, and to mechanical attack from outside, have all had to be faced, and it is only matter for wonder and admiration that such a conductor should have done so well. With its laying all the difficulties due to loss and induction disappeared, and a 10,000-volt transmission with a less than 3 per cent. loss became a fact, and we know to-day that the Ferranti trunk main, though now quite obsolete, was the only thing possible during the first few years of this decade for extra high tension transmission, and was the direct parent in design of the far more perfect high-tension and extra high-tension mains which may now be bought practically "off the shelf," for the difficulties which beset manufacturers of mains for high-pressure light and power circuits have now entirely disappeared, and for some years past it has been possible to obtain, and for no unreasonable outlay, absolutely trustworthy cables for almost any pressure.

When current was first put on the trunk mains between Deptford and London, a curious phenomenon occurred, in that the pressure over the system was increased by the mere fact of putting on a main by about 700 volts, and an increase of current was observed to be flowing into such main, although no load whatever had been put on to it at the other or town end. This curious effect was spoken of and written about, some seven years ago, as the Ferranti Effect—with a capital E—and a good many more or less curious explanations were hazarded by the wise ones, who are never at a loss to explain that which they do not understand. As the effect is still not generally understood, our readers will bear with us if we endeavour to make it clear. When the fact was first observed that the putting on of a main at Deptford threw up the pressure suddenly on the system, Watt meters had not been brought into any sort of general use at central stations, and the output was arrived at more or less empirically by the multiplication of the readings of the volt meters and the ampère meters installed upon the switchboards. As a matter of fact, it is now well known that the moment the four mains were first switched on, the current read on the meters augmented to 28 ampères, the electromotive force on the mains being kept at 10,600 volts, figures which would have previously been taken to represent something in the neighbourhood of 400-horse power. A careful indication of the engines revealed the fallacy of the figures, and brains were at once set to work to explain the mystery, a good many experiments being made before conclusions were arrived at by the engineers concerned. The rise in pressure was found to occur chiefly when certain machines were in use, these machines being the smaller ones, which had transformers connected to them for the throwing up of the pressure from 2500 volts, at which it was generated, to 10,000 volts, at which it was transmitted to London. When a main was put into work, at a time during which the larger machines, *i.e.*, those generating directly at 10,000 volts, was on load, the rise of pressure was noticeable only in a greatly modified degree, and did not amount to more than 100 volts. It became, therefore, clear that the rise must be due to the combination of the small machines and transformers with the mains. Everyone knows that electric energy is composed of two qualities, namely, pressure and quantity. The pressure, or electromotive force (E.M.F.) is measured in volts, and the quantity, or amount of current, in ampères, and nearly everyone knows that if we multiply the volts and ampères of a direct or continuous current together we shall get an accurate figure which correctly represents the energy flowing at the moment. The energy of an alternating current is also composed of volts and ampères, but no such certainty pertains to their admixture as is the case in a continuous current. The presence of capacity and of self-induction upsets the little sum, and these strangers must be disconnected before one can be sure that the energy is correctly known. An alternating current changes its direction and its intensity many thousands of times in a minute, and current and pressure have a curious desire or inclination under certain circumstances to shake themselves apart from each other. The volts and ampères in a standard circuit of alternating current may be shown in curves thus :—

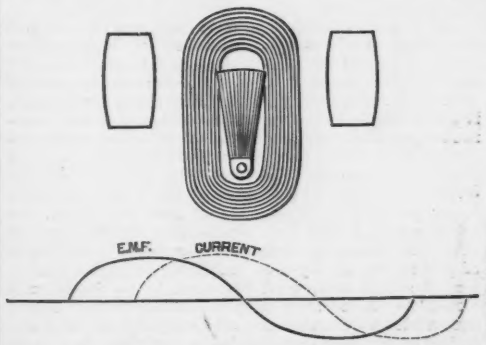


where the one curve shows both electromotive force and current, for it is of a simple circuit having neither self-induction nor capacity, and here the volts rise and fall simultaneously with the ampères, and if in this case we multiply one with the other, we do get the true watts or energy passing at a particular time. It was clearly not a circuit like this when the mains at Deptford were switched on, or the engines when indicated would have told a very different tale. There are two ways of effecting a change in a simple alternating current circuit, as indicated by the diagram above: (1) By putting self-induction into it—as, for example, by the introduction of transformers, arc lamps, &c.—in which case the current curve lags behind the electromotive force; and (2) by putting capacity in—as, for example, condensers—in which case the current will behave in an opposite manner, and get in front of the electromotive force. The first condition is called one of "lag," the second one of "lead."

The current and pressure when the mains are switched on do not rise and fall simultaneously, and therefore the mean current and the mean voltage which were shown on the instruments gave erroneous results when multiplied together. What happened, and does daily happen, no doubt may be seen by this diagram,

where the full line represents the electromotive force, and the dotted line the current. The mains having a considerable amount of electrostatic capacity in them, caused a "lead" on the circuit.

Now, such a lead has a peculiar effect upon the alternator, for the current curve being in advance of the electromotive force, magnetises to a certain degree the field coils of the machine, and increases the electromotive force of the dynamo.



This rough diagram may be taken to indicate the position of an alternator bobbin exactly between the pole pieces of a Ferranti alternator. The electromotive force in the coil at the particular instant chosen for the diagram would be zero; for it had just left one field and was about to enter that of the next pole. The current, however, in the bobbin being in advance of the voltage is not at zero, but acts upon the field magnet which it is approaching, increasing its magnetisation, and so increasing the electromotive force of the machine. It is quite conceivable that if enough capacity were put on to an alternating-current dynamo, it would be possible to have a machine self-exciting, *i.e.*, requiring no external source for magnetising its fields. The converse to all this equally applies, for if the current lags, the effect will be to demagnetise the fields and cause the pressure to drop. It is therefore evident that if a machine is supplying a circuit having self-induction, its electromotive force will be low;

do away with this effect, and allow the circuit to rise and fall together, and we require less exciting current; and now cause the current to be in front—lead—and we shall require still less current to excite the field magnets.

The smaller machines at Deptford when supplying current to the mains through the transformers produce a rise in pressure owing to this cause, and it has been found by experiment that the greatest rise in temperature on the mains takes place when the "lag" caused by self-induction exactly corresponds to what would be the "lead" due to the capacity, *i.e.*, 43 deg. either way in advance of or behind the electromotive force curve.

In other words, let us imagine a machine running on a circuit possessing self-induction, one on which there are transformers, and we know that the current will "lag" behind the electromotive force, and tend to demagnetise the "fields." Let us assume that such "lag" is 45 deg. behind the electromotive force. We now switch in mains whose capacity is sufficient to throw the current 45 deg. in *front* of the electromotive force, and we shall produce a condition of things which will affect the maximum rise on the mains. It will be readily understood that the rise in pressure, as it took place the instant a main was switched on, was not quite a thing all of joy, for it produced a sudden accession of light on all lamps, and a serious sudden strain upon the entire system, which continued until the exciting current had been reduced, and the engines steadied upon their governors under the new condition of affairs. Mr. G. W. Partridge, the chief assistant engineer of the London Company, proposed an arrangement which has long been known, and most successfully so, as a main discharger. It consists of a coil of wire wound upon an iron core, and above the winding is a second coil similar to an ordinary transformer. When a main is to be switched in it is put in series with the principal coil of the apparatus, and the other coil is gradually short-circuited by means of a water or a carbon resistance. The main is thus charged up gradually, and the volts, instead of coming up with a rush, are kept at an uniform pressure, as the exciting current of the alternator can be adjusted at the same time, and as slowly as the short-circuiting of the main discharger. The taking off of a main is, of course, effected by means of the same apparatus, contrariwise, and its use, both in the putting on and taking off of mains, has greatly reduced the danger of faults being established, or of any breakdown upon the transformers connected to the London end of the main itself. Previously to the adoption of Mr. Partridge's apparatus, the history of the Corporation's working shows many failures of mains and of transformers at the moment of the bringing into work or of the withdrawal from work of a main. An interesting fact was very early demonstrated by the use of the apparatus. On gradually short-circuiting the one coil, the pressure rose upon the main itself until it had reached that of the rest of the system; the main should then in the ordinary course of events have been plugged on to the omnibus bar, but leaving this undone, and continuing to short-circuit the coil, the electromotive force upon the main was observed to be about 2000 volts above the pressure of the whole system, in this way giving a proof of the effect of a variation in the self-induction on a circuit which has capacity in it, causing an alarming rise in pressure.

The engineers of the London Electric Corporation have gained wide and valuable experience in extra high-tension mains, during the many years which have elapsed since Mr. Ferranti's immediate connection with that great pioneer company ceased; and we know that in the thirty-five miles of trunk mains now in use there are many miles of cable made by the British Insulated Wire Company, and by Messrs. Siemens Brothers, running without trouble in parallel with much of the Ferranti main, the survival of the fittest of it which remains. The whole question is one which possesses much interest, because of what has been done by the London Company, what is immediately to be done by the Metropolitan Company, and what is being spoken of now as being prospective to many other companies.

Up to 1890 vulcanised india-rubber had been almost exclusively used for the insulation of high-pressure mains; but with the advent of extra high pressures, and the rapid developments of transmission and distribution with high voltages which took place about that period, it was found that the large radial thickness of the india-rubber required made the cost of such cables practically prohibitive, while their enormous capacity rendered them impracticable. The cables used for 2000-volt distribution previous to 1890 were of the single conductor form, and were generally drawn into iron pipes, the prime reason of their being single being the great expense in making them concentric; as, if an equal radial depth of rubber was employed on both inner and outer conductors, the outer cost a good deal more to insulate than it would have done in the form of another single. Again, concentric rubber cables are extremely difficult to build, owing to the fact that the inner insulation has to be vulcanised twice over—once on its own account, and again when the outer rubber is vulcanised. The first users of mains, then, in the proper sense of the word, as we stated at the beginning of this article, were the London Electric Supply Corporation, with their overhead work from the original generating station underneath the Grosvenor Gallery, in Bond-street, in point of age. Next came the House-to-House Company; after which followed the Metropolitan, to be followed by the City of London Company. The last-named was the first to make an attempt to use india-rubber insulated concentric cables, but many serious breakdowns followed, owing to the full pressure getting on to the outer conductor, which was not earthed at the omnibus bar in the station. Our readers will remember the Cannon-street accident, which was found to be due to the accidental putting to earth of the inner conductor of one of these cables, which raised the outers to 2000 volts above earth, a fault at once developed on the outer conductor, charging up a length of pipe in which it was laid, as well as the street itself, and killing a horse. We fear that it is a very common fault with cable makers, even at the present day, that they do not trouble to thoroughly understand what it is they are required to make, nor to find out if it is intended to run their cable with the outer earthed. Cables which are not insulated on the outer are oftentimes put upon earthed circuits, with consequent breakdowns.

The earliest instance of an india-rubber insulated cable being used for practical purposes on an extra high-tension circuit was at the Frankfort Exhibition, which was held in 1891. In the machinery hall alternating current at a pressure of 2000 volts was obtained from a 450-horse power dynamo, and was transformed to 20,000 volts, and was at that pressure transmitted to the exhibition on the Maine, and then used, after another transformation, for lighting purposes. The cable was of the twin pattern, and consisted of two conductors, each being composed of six 15¼ B.W.G. covered with vulcanised india-rubber of a radial thickness of 0·4in., and taped. These two cores were twisted into a spiral filled out with yarn worming to a cylindrical section, and finally covered with jute covering and compounds. The cable, which was made by Messrs. Siemens Bros. and Co., Limited, had been previously tested at their works with 40,000 volts. It has since been subjected to a pressure of 60,000 volts alternating current without injury, and is still in use at their Woolwich works in connection with the high-tension testing of the new Siemens lead-covered cables, the electromotive force occasionally rising to a pressure of upwards of 70,000 volts. Broadly speaking, however, the india-rubber cables have gone wrong all over the country, and the change in the affections of the City Company from rubber to paper cables may be marked as the period when the failure first set in. The Blackpool cables, mainly Silvertown, after working for about three years, had to be entirely scrapped, and in Huddersfield, Leeds, Coventry, Derby, Portsmouth, and Cardiff, the rubber cables have proved to be so unsatisfactory that in many cases they have been replaced, while the City Company and the House-to-House Company have entirely discarded them.

Cables insulated with fibre in the shape of fine yarns or cotton impregnated with resinous or bituminous compounds, and those wherein the insulation is provided by wrappings of jute impregnated with bitumen, were and are still in common use on circuits up to, say, 2500 volts alternating current, but they are quite out of the question for extra high pressures, as such mediums merely serve for holding the compound used, having no mechanical strength of their own.

The introduction of several new insulating materials, which have proved themselves to be highly satisfactory, combined with the great progress which has been made in manufacture, have enabled extra high tension mains to be placed upon a sound commercial footing. Of these by far the most extensively used are the oiled papers adopted by the British Insulated Wiring Company, of Prescot, and the "non-hygroscopic material" patented by Messrs. Siemens Bros. Both of these substances are wound on the conductors in the form of tape, and possess extraordinarily high volt-resisting properties; in fact, although the Board of Trade Regulations require a dielectric thickness of ¼in. on a 10,000-volt circuit, half that amount would be ample for either of the above-named cables. It seems a pity that the Board of Trade should lay down so arbitrary a law, and we are of opinion that the question of the depth of insulation to be provided should be left to the combined intelligence and experience of the manufacturers and the engineer who is specifying for his needs. The Board of Trade rule for the thickness of the insulation of any cable is that it shall not be less in inches, or parts of an inch, than the number obtained by dividing the number expressing the voltage by 20,000. In plain English, this means $\frac{1}{10}$in. for 2000 volts, and, of course, ½in. for 10,000 volts. Such a provision of the Board is more or less nonsense, as it is, we believe, based upon the assumption that at some time or another there will be a hole in the insulation, and that their regulation provides sufficient distance to prevent the jumping of current through such a hole from one pole to the other. As a matter of common knowledge, any of the alternating-current engineers will tell how, when, the equilibrium of their system is upset owing to the failure of a pair of bobbins in an armature, the blowing of a fuse, the failure of a main, the breakdown of a transformer, the opening or closing of a switch, or from any other cause, the pressure on the line rises momentarily to very much more than the working stress, and hence the sparking across would be certain. The Board of Trade may give up the hole theory, for if a hole did by accident occur in the dielectric of a 10,000-volt main, that pressure with, say, 2000-horse power behind it, would not waste much time in taking such a nice little short cut. Assuming that the thickness of the insulation should be left to the manufacturer without legal interference, there is no doubt that the purchasing engineer should assure himself that the manufacturer has allowed a sufficient margin, and to this end short lengths of the cable should be tested by him to at least five times the working strain in the case of 2000 volt cables, and to still more for extra high tension mains, for in the latter case there is little doubt that the higher the working pressure the greater is the proportional rise of potential in the event of the sudden disturbance of the equilibrium of the system. The Prescot and the Siemens non-hygroscopic cables, which carry a little over 10,000 volts from Deptford, have been subjected, we believe, in this way to a test pressure of from 80,000 volts to 100,000 volts before being definitely accepted. A curious fact was observed during one of the tests, in that the insulating material, and, in fact, the whole cable became quite hot in the hand, and this was attributed, no doubt quite rightly, to the passing of actual current through the insulating material. The amount could not have been more, including the leakage over the ends, than the 1000th part of an ampère, but even this small current at 90,000 volts represents a fair amount of energy. During a recent visit paid to Deptford we were enabled to notice a similar fact in connection with the testing of some vulcanite caps for the pole pieces of the new 1500-kilowatt alternator, which is rapidly approaching completion in that station. The caps were placed bottom downwards in a shallow bath of mercury, and a quantity of mercury sufficient to completely immerse the surface was poured inside; a small alternator was then run up, the two poles being represented by the two bodies of mercury. The test pressure recorded amounted to 20,000 volts for ten minutes, with a run up to 25,000 volts for a further half minute. Upon switching off the machine, the tested cap was found to be so hot that the hand could not be borne upon it, but no sign of any deterioration could be observed, and the quantity of current flowing could not have been detected on the most sensitive ampère meter.

A number of interesting experiments having reference to the comparative volt-resisting properties of various insulating materials are recorded in a paper by Mr. Alexander Siemens, which was read before the Institution of Electrical Engineers in February, 1892, and which had as its title "Some Experimental Investigations of Alternating Currents." The following table has been compiled from a diagram given in that paper:—

Sparking Distance of Insulating Materials.

Volts.	Impregnated fibre.	India-rubber.
5,000	3 mm.	0·25 mm.
10,000	9 mm.	1·0 mm.
15,000	17 mm.	2·4 mm.
20,000	25 mm.	4·0 mm.
38,000	—	10·0 mm.

In comparison with the above, 2·5 mm. in thickness of the Siemens non-hygroscopic material withstood 13,000 volts, and 8·5 mm. has failed to break down with a gradually applied pressure of 50,000 volts alternating current. Of course, the test made on the latter was carried out long after those named in the table above, but the comparison still holds good, and very clearly demonstrates the great strides which have been made even in the few years which have passed since 1892.

Lead-covered cables are now almost universally used for high tension. Though Messrs. Callender laid down seven so covered—in, we believe, 1884 or 1885—it was not generally adopted, and even as late as 1892 the total quantity was very small indeed. Now, for all fibre-insulated cables a lead covering may be said to be indispensable, and it is almost equally necessary for non-hygroscopic insulations, on account of the mechanical protection which it provides, and also for rubber cables. The work done in lead-covered cables during the last four years has been not less than ten times as much as had been done previously to that date. There appears, however, to be a growing tendency on the part of engineers to obtain mains which are not entirely dependent upon the lead covering for their protection, and which will not break down should the lead be pierced in any way; and some of our leading contractors have adopted a system of having the insulation between inner and outer protected by one lead sheathing, a further sheathing being placed outside the insulator of the outer conductor, thus making the insulation between conductors independent of any damage to the outside lead. This is an excellent step forward, for anything which tends to relieve the engineer of anxiety about his mains cannot be too highly commended. A cable which is constructed of insulation impervious to water, and which is covered with lead, appears to be the one which will outlast all others, and it were false economy to adopt any other type on account of lower initial cost. It should be the duty of the engineer to satisfy himself that the insulation does possess such quality, and the best way to assure himself upon such a point would be to specify a voltage test on a cutting of the cable which had been immersed in water, with the lead covering stripped off, for at least twenty-four hours. The thickness of the lead on a finished cable ought to be ample, bearing in view the expensive nature of the cable, and the fact that after all the life of the lead may be said to be the life of the cable, for should the lead be defective, or become, may we say, "punctured," it is not likely that any insulation now in use would indefinitely withstand the insidious attack of acid water, or other "wet chemical mixtures" which permeate the grounds wherein the cable is laid. As a matter of practice it has been found that the thickness of lead should be not less than one-tenth of the total finished diameter of the cable, and at least the two principal makers put more than that upon their manufacture. A good deal of nonsense is often heard with regard to the testing of a cable, and some engineers, generally young men—or, if not young, then professors—lay down wonderful figures of insulation resistance, &c. The practical engineer, however, knows that high initial insulation resistances are unnecessary—a comparatively low but constant one is far more desirable; and the best way to test for it is, not in short lengths in the factory where the connections form such an important item, but after the cable has been laid and jointed up into position. To get an exceptionally high insulation resistance test, where the dielectric used is other than india-rubber, the manufacturer is obliged to use material between the conductors which must be very dry, and, as a necessary consequence, very short or brittle, and in the practical working of such a cable it is very likely, indeed quite certain, that the insulation will develope cracks, which may be expected to speedily produce faults.

THE Board of Trade have recently confirmed an Order intituled "Bankfoot Light Railway Order, 1898," authorising the construction of a light railway in the county of Perth, between Strathord Railway Station and Bankfoot.

NEW EXPRESS ENGINES ON THE GREAT EASTERN RAILWAY.

By CHARLES ROUS MARTEN.

IN THE ENGINEER of October 28th there was published a large illustration of the new type of express engines recently designed by Mr. James Holden, locomotive superintendent of the Great Eastern Railway, for the seaside express service of that enterprising railway, and constructed at the company's works, Stratford. The principal dimensions of the engines were also given.

It would be noticed that there are in these engines several novel features, as compared with Mr. Holden's previous practice. In the first place, the stroke of the piston has been lengthened from 24in. to 26in., this being the only instance of so long a piston stroke being used in express engines on the Great Eastern line. Next, the 7ft. single driving wheels have outside as well as inside bearings, and have the large weight of 19 tons available for adhesion. Further, the leading end of the engine is carried on a four-wheeled bogie, and the liquid fuel, which the locomotive is fitted to burn according to Mr. Holden's very successful system, is conveyed in side-tanks on the tender. Also, as a matter of outside appearance, it may be noted that the chimney is of the Swindon pattern, with copper top. The new engines, which are numbered 10—19, and are painted the usual Great Eastern blue, picked out with black and red, have a very handsome appearance. It will now be interesting to see what their performances are like.

Through the special courtesy of Mr. Holden, to whom I have to express my cordial acknowledgments for the valuable facilities afforded, and for the thoughtful consideration shown for my convenience and personal comfort, I have been able to make several experimental journeys with these fine engines. I proceed to record the results attained.

The Great Eastern line, although not exceptionally infested with severe gradients, nevertheless possesses several of a distinctly trying character, and also, what is far worse, an excessively crowded road on the first seven miles out of London, involving frequent obstruction by signal checks and stops. This is especially detrimental to the up expresses, which often arrive within six or seven miles of their destination well in advance of booked time to allow a margin for these habitual delays, only to find themselves some minutes late at Liverpool-street. It is not easy to see how this can very well be remedied under existing conditions, but it is none the less regrettable.

The principal duty of the new engines is to run the fast expresses between London, Ipswich, and Cromer. It will therefore be useful to give in brief form the general gradients along that portion of the Great Eastern line. Three-quarters of a mile after starting from Liverpool-street, a very steep ascent of 1 in 70 has to be climbed for half a mile. Then there is a drop of 1 in 354 for three miles to a little past Stratford; next there is a steady ascent on moderate grades for nine miles, passing Harold Wood. Then comes a severe bank for 3¼ miles, passing Brentwood, the gradients being chiefly 1 in 91, 97, 99, 93, and 84. The summit is at the 19 mile-post. Next, the line falls continuously on varying grades, most, however, being steeper than 1 in 200, for 11 miles, passing Chelmsford. It then undulates slightly, but keeping generally about the same level to 48¼ miles, next dropping more steeply, mostly at 1 in 128 and 165 for four miles, passing Colchester. A two-mile rise at 1 in 123 and 144 immediately follows, and after a level stretch Manningtree is approached by a fall of 1 in 134 for three miles, a length of general rise, chiefly at 1 in 145 and 157, succeeding, which is followed by a sharp drop of 1 in 130 and 120 for three miles, which, with a subsequent mile of level, brings us to Ipswich. The line is mostly on a slightly rising grade thence to Stowmarket, and next rises for four miles, much at 1 in 131, to a point near Finningham.

For seven miles there is mostly an easy downward grade, for two miles after Mellis a fall at 1 in 132. A moderate ascent follows to the 99 mile-post, then 2½ miles of dead level; passing Tivetshall, succeeded by a drop at 1 in 131 for a mile and a-half after Forncett, and a similar rise past Flordon. A generally easy descent, but with a concluding mile at 1 in 86, brings us to Trowse, 114 miles, and just afterward a swing-bridge is crossed at a walking pace, a man being picked up at one end and set down at the other. The line rises gently to Whitlingham, and then very steeply at 1 in 80 for a mile, an easier grade, mostly upward, following to Salhouse summit, whence there is a descent much at 1 in 88 and 150 to Wroxham, succeeded by a stiff climb—one mile at 1 in 80—broken by a mile of easy fall at Worstead, to North Walsham, 130½ miles from London, where the first stop is made. An almost unbroken ascent, much at 1 in 100, continues the rest of the way to Cromer. The line after Wroxham is single, so that speed has to be reduced at every station sufficiently for the staff to be exchanged.

It will thus be seen that the task to be performed by the engines is by no means an easy one. The "express" running may be said to end at Trowse, to which point the booked time is 2 h. 15 min. for the 114 miles, or at the average rate of a mere fraction under 51 miles an hour. For the following 16½ miles to North Walsham, where the first stop is made, it is found necessary to allow as much as 25 minutes, to provide a margin for the delays caused by junctions, sharp curves, swing bridges, and slacks for staff exchanges along the single-line lengths.

The special Cromer express, which leaves Liverpool-street daily during the season at 1.30 p.m., usually consists of three of the new and very comfortable bogie coaches, and eight six-wheelers, making eleven vehicles in all, weighing approximately 175 tons.

On the occasion of my trip with this train the load was the normal one. The weather was fine, and the rails dry. The Bethnal Green bank of 1 in 70 was ascended very easily, but near Coburn-road adverse signals brought us almost to a dead stand. Fives miles farther on heavy road repairs brought us down to 10 miles an hour for nearly a mile. The steep bank past Brentwood was climbed very steadily, the minimum speed up the 1 in 84 being 25·7 miles an hour. The subsequent descent to Chelmsford was run mostly at 65·4 to 69·2 miles an hour, and the short rise of 1 in 123 which follows was ascended at a minimum rate of 52·8. Another relaying slack was encountered soon after Kelvedon.

In spite of all hindrances, Colchester was passed in 52 min. 59 sec. from the start. The brief rise at 1 in 123 which follows was ascended at 52·8 miles an hour. Water was picked up at speed just before passing Ipswich. The time to Ipswich was 81 min. 59 sec., or 3 min. 1 sec. under booked time. Yet one more slack for re-laying occurred, in this case near Diss, speed being reduced for a considerable distance. Soon afterward the maximum speed of the trip was attained, 70 miles an hour being just touched. Water was again picked up at speed near Tivetshall. Trowse station, 114 miles, was passed in 134 min. 18 sec. from London, but 7 min. 14 sec. had been lost by the various delays, so that the actual net time to Trowse for computing locomotive work was 127 min. 4 sec.

The remainder of the journey calls for little remark. The mile of 1 in 80 was run at 36 miles an hour, and North Walsham, 130½ miles, was reached in 2 h. 38 min. 58 sec.—or in 2 h. 31 min. 44 sec. net time from London. The performance was undoubtedly a very good one. Our arrival at Cromer was punctual to the minute. The engine appeared to steam very freely and well throughout, and quicker time could easily have been made had this been desired. But absolute punctuality was observed, and no more was needful. I append the log of the run.

Two up journeys with engines of the same class, from Ipswich to Liverpool-street, deserve notice. In each case the load was sixteen six-wheeled coaches, weighing in all 210 tons, behind the tender. The logs of their runs, which I append, explain themselves, and call for no detailed elucidation. It will be observed that in one case the run of sixty miles to the first signal stop was made by engine No. 15 in 77 min. 6 sec., with a bad re-laying check midway. The last nine miles into London occupied no less than 25 min. 38 sec. owing to signal delays. This speaks eloquently of the detentions to which up trains are subjected. In the other case, engine No. 12 ran the sixty miles to the bridge-repairing slack in 76 min. 31 sec., in spite of a very bad check—almost a stop—at Boreham Box. The last nine miles to Liverpool-street occupied 18½ min. owing to signal delays.

While treating of the Great Eastern Railway, I have thought it worth while to give the logs of two experiences with the fastest timed run on the line, that from Trowse to Ipswich, 45¼ miles, in 50 min. It will be noticed that in one case the time was 48 min. 53 sec., and in the other 47 min. 24 sec., both being well within the booked allowance. The engines ran under easy steam, and got in before time without effort. The run could have been made several minutes quicker had this been required. As it was, the performance was a very creditable one.

The respective logs are as follow:—

Engine No. 19, *New Class*, *Load* 175 *Tons.*

Miles.		Stations, &c.		Actual times. h. m. s.
—	...	Liverpool-street	dep.	1 30 40
—	...	Signal slack, 5 m.h.		37 1
4	...	Stratford	pass	39 17
6½	...	Manor Park	,,	42 22
7½	...	Ilford	,,	43 39
—	...	Slack for bridge repairs, 10 m.h.		45 15
10	...	Chadwell Heath	pass	47 54
12½	...	Romford	,,	51 12
15	...	Harold Wood	,,	54 29
18½	...	Brentwood	,,	58 55
20½	...	Shenfield	,,	2 2 28
23½	...	Ingatestone	,,	6 1
29½	...	Chelmsford	,,	11 46
36	...	Hatfield Peveril	,,	18 22
38¾	...	Witham	,,	21 10
42½	...	Kelvedon	,,	24 49
—	...	Re-laying slack, 12 m.h.		27 0
46½	...	Mark's Tey	pass	29 30
51¼	...	Colchester	,,	33 29
56	...	Ardleigh	,,	39 15
59½	...	Manningtree	,,	42 47
63½	...	Bentley	,,	46 32
68½	...	Ipswich	,,	52 39
71½	...	Bramford	,,	55 39
73½	...	Claydon	,,	58 10
77½	...	Needham	,,	3 2 11
80½	...	Stowmarket	,,	6 9
83	...	Haughley	,,	857
86½	...	Finningham	,,	14 20
91½	...	Mellis	,,	19 24
—	...	Re-laying slack, 15 m.h.		22 28
95	...	Diss (slack)	pass	23 12
97½	...	Burston	,,	28 41
100½	...	Tivetshall	,,	30 52
104	...	Forncett	,,	34 40
106¾	...	Flordon	,,	37 8
109¾	...	Swainsthorpe	,,	40 8
112¼	...	Trowse (Upper Junction), slack	,,	43 8
114	...	Trowse Station, slack, 5 m.h.		44 58
—	...	Swing bridge, slack, 2 m.h.		46 28
115¾	...	Whitlingham	pass	49 39
119½	...	Salhouse	,,	55 42
123	...	Wroxham (slack for staff)		58 46
127	...	Worsted ,, ,,		4 4 59
130½	...	North Walsham	arr.	9 39
			dep.	12 33
138	...	Cromer		4 25 0

(A) *Engine No.* 1004 (*see note*), *Load Four Coaches.*—(B) *Engine No.* 724 (*see note*). *Load Six Coaches.*

Miles.		Stations, &c.		Actual times. (A) h. m. s.	(B) h. m. s.
—	...	Trowse	dep.	8 53 34	8 50 12
4½	...	Swainsthorpe	pass	9 0 24	56 27
7½	...	Flordon	,,	4 8	59 36
10	...	Forncett	,,	6 51	9 2 13
13½	...	Tivetshall	,,	10 42	5 55
16½	...	Burston	,,	13 52	8 50
19	...	Diss	,,	16 7	11 4
22½	...	Mellis	,,	19 46	15 56

NOTE.—Engine No. 1004: 7ft. single, cylinders 18 by 24, liquid fuel burning. Engine No. 724: 7ft. coupled, cylinders 18 by 24, coal burning.

(A) *Engine No.* 15 (*new class*), *Load Sixteen Coaches.*—(B) *Engine No.* 12 (*new class*), *Load Sixteen Coaches.*

Miles.		Stations, &c.		Actual times. (A) h. m. s	(B) h. m. s.
45½	...	Ipswich	dep.	9 53 14	9 50 29
50¾	...	Bentley	pass	10 4 20	10 1 7
54½	...	Manningtree	,,	8 27	5 3
58	...	Ardleigh	,,	13 13	9 54
62¼	...	Colchester	,,	18 24	15 1
67¼	...	Mark's Tey	,,	24 32	21 19
71¾	...	Kelvedon	,,	29 53	26 34
75¼	...	Witham	,,	33 53	30 37
78	...	Hatfield Peveril	,,	37 28	34 14
—	...	Boreham Box	,,	—	38 43
					Re-laying slack 10 m.h.
84½	...	Chelmsford	,,	44 18	42 45
90¾	...	Ingatestone	,,	54 0	50 48
93¾	...	Shenfield	,,	58 55	55 31
95¾	...	Brentwood	,,	11 1 58	58 31
99	...	Harold Wood	,,	4 47	11 1 30
101¾	...	Romford	,,	7 6	3 57
104	...	Chadwell Heath	,,	9 19	6 17
—	...	Signal slack 5 m.h.	...	11 1	7 0
106¾	...	Ilford	pass	14 18	10 45
107¼	...	Aldersbrook Box	...	—	12 0
					Sig. slack 5 m.h.
107¾	...	Manor Park	pass	—	13 12
108¾	...	Forest Gate	,,	—	15 17
109½	...	Maryland Point	arr.	18 12	—
			dep.	20 1	
110	...	Stratford	pass	22 2	17 17
				Stop twice signals	
112¾	...	Bethnal Green	pass	32 7	22 13
113½	...	Bishopsgate (signal)	,,	34 30	a. 23 40 / d. 24 10
114	...	Liverpool-street	arr.	11 35 58	11 25 29

It only remains to add that the new bogie coaches proved exceedingly comfortable, and ran very smoothly; also to express my thanks to Mr. Bell, of the Great Eastern Locomotive Department, who accompanied me during each of my journeys, and who furnished me with much valuable and interesting information.

AUXILIARY WATER SUPPLY FOR FIRE PROTECTION IN AMERICAN CITIES.

THE enormous value of buildings and property in the business and industrial sections of large cities calls for very complete protection against fire; but in many cases it is difficult to use high pressures on the regular water mains, particularly such pressures as would be required to throw streams to the top of the high office buildings. Cities on the coast, the great lakes, and the large rivers usually have fire boats for the protection of water front property, these vessels usually resembling large screw tugs, and being fitted with very powerful pumps. A very general proposition for increased fire protection is to lay special water mains for fire purposes, through which water can be pumped with great effect by the powerful machinery of large capacity on the fire boats. This system has already been installed in five cities, and an appropriation for it has been made by the city of Chicago. The following particulars respecting these five plants are taken from a report recently made to the New York Fire Department by Mr. Bonner, chief of the department:—

The city of Boston has recently laid with great care, and at considerable expense, about 4000ft. of extra heavy 12in. cast iron pipe, with improved fire hydrants attached about 200ft. apart, with two 3½in. discharges, and a separate valve for each discharge. A separate tube is laid near the pipe line for an electrical conductor, to be used in communicating between the boat and any part of the line. It will be used as a dry system during the winter season, but at all other times the pipe line will be charged with fresh water, which will be maintained in position by the use of check valves at either end. It has not been put in practical operation as yet. It is laid with the intention of extending the system throughout the entire district, or where the fire risk is considered the greatest, in the near future.

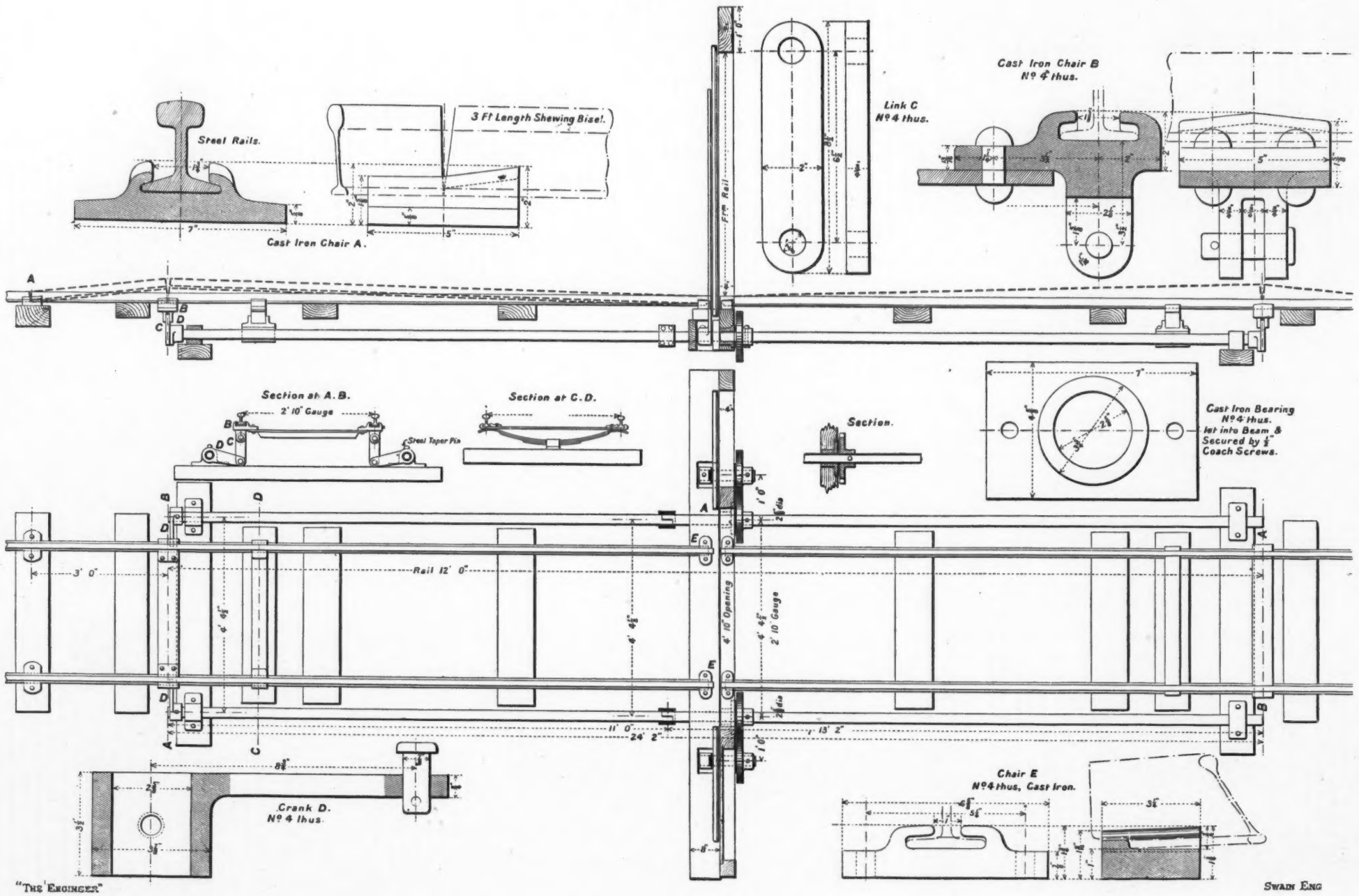
The city of Cleveland has several of its important streets equipped with cast iron pipe lines varying in size from 8in. to 10in., and connected to improved hydrants with separate valves to each discharge, also separate tubes for the use of an electrical conductor, conducting the boat with the pipe. At a test given on land, two streams, with 1⅞in. and 2in. nozzles, were thrown a long distance and over a bluff having an elevation of about 100ft. The pipe line was also connected to stand pipe and deck pipe on the water tower, and did excellent work with one boat at work on pipe line.

Milwaukee has about 7½ miles of cast iron pipe laid, varying in size from 6in. to 8in. or 10in., running through the important sections of the city, and branching off to points of danger. The hydrants are of improved pattern, with cut-offs from the main, and separate tubes for an electric conductor. The dry system is used, with drainage by gravity to the sewers. At a test given, two lines with 2in. and 1⅞in. nozzles were taken from the same hydrant, and streams thrown to a great distance. This is the most extensive of any line yet in use. It has been used most successfully on more than one occasion, and was mainly instrumental in preventing the extension of several large fires. The system is so highly appreciated by the authorities that it is proposed to extend it yearly until the system is laid throughout the district where great fires are likely to occur, and it is fully believed that this method is the only safe one that would tend to prevent the extension of conflagrations in the future.

Detroit has about five miles of wrought iron pipe with sleeve screw jackets, tested to 1000 lb. to the square inch, varying in size from 8in. to 10in. It is on the dry system, and supplied with air valves and cut-offs at various points on the line, the greatest elevation being about 50ft. An improved pattern of hydrant is used, and there is a separate tube for electric conductors. At a test two streams from one hydrant,

AUTOMATIC COLLIERY AIR DOOR

(*For description see page 535*)



with 2in. and 1⅞in. nozzles, were thrown a great distance. They were then siamesed, with a 2½in. nozzle, and thrown to a height of about 150ft., with only one boat working on the line. Mr. Bonner says this is the best stream that he has ever seen. It was forced from a distance of a mile and a-quarter, and a more powerful and greater stream could not be obtained by the concentration of half a dozen of the heaviest land engines. It is expected to extend this line yearly, mainly to the commercial and other sections where most required, and also on the river fronts. It is also now under consideration to place a permanent pumping plant, located on the river front, so that if necessary the boat could be relieved and allowed to perform duty elsewhere.

Buffalo has a fire system of about 6200ft. of wrought iron pipe, with sleeve screw joints, tested to 1000 lb. The dry system is used, with drainage by gravity to the sewers. Its elevation through the centre of the city is about 50ft. at the highest point. Air valves and cut-offs are provided at various points on the line, with the most improved four-way hydrants, having 3½in. discharges. A separate tube for electric conductor connecting to the post adjoins the hydrant on the sidewalk. The exhibition of two streams at the end of the line with 2in. and 1⅞in. nozzles was excellent, when the great distance from the boat is considered, and the amount of power utilised in forcing the water a distance of nearly a mile and a-quarter. When siamesed to a 2½in. nozzle the stream was thrown to a great height and distance. It is one of the most powerful streams ever witnessed, and far greater than could possibly be obtained from the power of the largest land engines when concentrated at any given point. The stream would certainly hold in check, if not entirely subdue, a fire of more than ordinary magnitude, and the result of this was entirely due to the operation of one boat, which was on duty forcing water through the line.

The line in the city of Buffalo is probably the best of its kind laid up to date. Together with Boston it has had the experience of many other cities, and has used this to good advantage by cutting out defects and adding improvements, which, when combined with the improved hydrants, cut-offs, and valves, give these cities the best systems of any yet in use. It is the intention of the authorities to extend this system throughout their commercial centres and to all danger points on the water front, where this system is so much needed to enable the department to successfully compete with fires when they occur among the immense grain elevators.

Mr. Bonner states that, after a careful study of the fire-protection pipe system as now used by the above cities, there can be no question as to its practical utility, and as to its being the most economical auxiliary plant that any city could apply for its protection against fires. The streams of water that these pipe lines can deliver is far greater in power than could possibly be obtained from a number of the largest engines on land, and with a number of such lines well located on the front of a fire as well as on the rear, it would be safe to say that no fire could possibly extend beyond the effective points of those streams. These cities have taken advantage of a system that will prevent great conflagrations in the future by utilising the power of the fire boats that are usually lying idle during the progress of great fires in the hearts of their cities.

The system is so highly appreciated by the city authorities that they propose to continue adding to it yearly until dangerous sections of their cities shall be entirely encircled by the pipe-line system, and in one instance at least this system will be operated by a permanent pumping plant, located near the river front, which will operate in conjunction with the fire boat or relieve the boat at any time if it should be required elsewhere.

The defective points in the systems as now operated lies in the fact that, as now laid laid out, they have omitted to protect the roofs and rears of buildings, either of which positions during the progress of fires is just as important as the street in front of the fire. Great fires extend by the roof, and strip roofs of buildings hundreds of feet ahead from the seat of the fire, and generally follow the currents and direction of the wind. With this pipe line extended to the roof, and continuing in a circuit around each block, with discharge gates for hose connections at about every 200ft. or less, and with a main pipe to the roof connected with the underground system, or with an auxiliary pump located in the vicinity, ample protection would be rendered for the roofs and rears of buildings from the same system. It would also prevent the delay caused by hauling great quantities of hose to the roof which otherwise must be done, if it is desired to protect the roofs at any time during the progress of a fire. This is practically the only point of demerit in the pipe line system; its continuance to the roof would be but a trifling additional expense, and would protect that part of a building which is so easily stripped and fired during the progress of great fires.

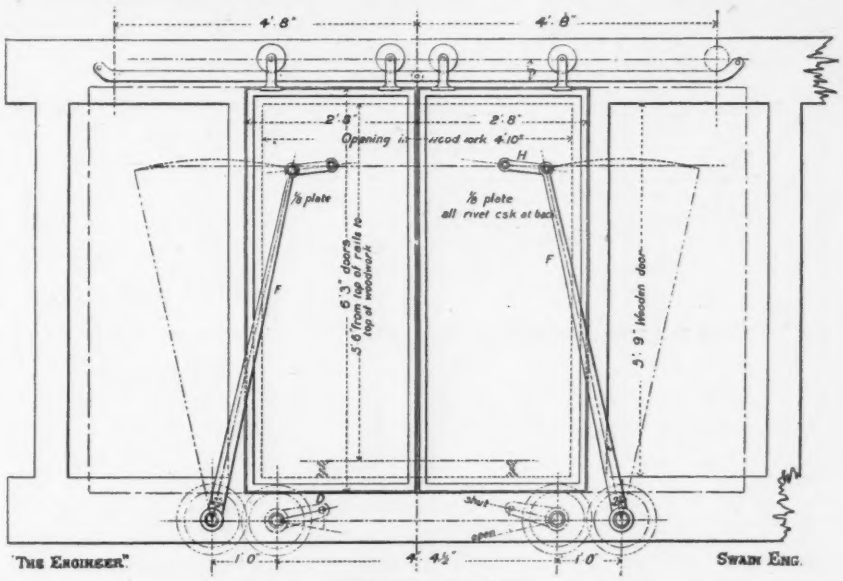
There is no city better adapted for the use of the underground pipe system than is New York, owing to its peculiar geographical lines. There are but few points where the total length would exceed a mile and a-half, the city having an abundant supply of water on both sides. With a pumping capacity of 23,500 gallons per minute, that is rarely, if ever, used for fires in our commercial centres, there is no reason why this system should not be utilised to a greater advantage than in any of the cities now having such a system in use.

We must realise the fact that the capacity of land engines to force water to great heights has been reached. When greater power is required to force water to meet conflagrations, and to great heights, it must be obtained from other sources than the steam fire engines now in use, and there is no system that could better be recommended than the one under consideration. There are high buildings in New York that are entirely beyond the ability of the machinery of the Fire Department to force water to the upper stories. It must also be considered that the tall buildings of the present day, as well as the mercantile buildings, are of greater height and cover larger areas than ever before, and that fires will entail great loss if not promptly checked. If the department is not able to control the fire and surround the structures with large quantities of water, there is a possibility that such fires will extend and become great conflagrations. This source of danger can be obviated by adding an auxiliary plant for the use of the department in the form of the underground pipe line, connected to a roof line system, as well as an aërial line, which should connect to all of the tall buildings. This should be fed from the underground system, and also from our city mains, with the aid of auxiliary pumps—electric or steam—located at different points in the city. By the use of the auxiliary pump water could then be forced to the topmost story of any building, no matter how high, as well as to the circuit on the roof line, and would render positive protection against any extensive fire in that section of the city.

The city is long and narrow, with the North Hudson River on one side and the East River on the other side. The plan proposed is to lay large mains from the East and North Rivers to the line of Broadway, as well as a line from the Battery—on the harbour at the south end of the city—running parallel with Broadway. These would have cut-offs at different points, and would encircle every danger point, including the dry goods and commercial districts, high buildings, department stores and factory districts, and also protect the entire water fronts on the East and North Rivers. The pipe lines to the roofs and the aërial line for the use of the high buildings would be connected to the city mains, as well as to the underground system, with auxiliary pumps for the use of the aërial pipe line. The whole pipe system would also be so arranged that connections could be made to the city waterworks mains at any time if necessary.

AUTOMATIC COLLIERY AIR DOORS.

TENDERS were recently invited by Mr. Stephen Humble, 9, Victoria-street, Westminster, for the supply and delivery of all the ironwork complete for two sets of colliery air doors, in accordance with the accompanying sketches. The object of the arrangement is to keep the doors always closed, except when trucks are required to pass through. It will be seen from the drawing on page 534 that the rails rise slightly from whichever side the door is approached; the apex of this rise on either side being about 12ft. from the doors, the rails are kept up in this position by a spring under the plate that connects them. The action of the arrangement is as follows:—When a vehicle approaches within about 15ft. of the door the wheels come upon the inclines and force the rails down to a level position, and in so doing depress the cranks on the ends of the long shafts and cause the cog-wheels in centres of long shafts to revolve; these cog-wheels gear into similar ones on parallel short shafts, and move the levers keyed thereto and thus open the doors. The doors will remain open so long as the rails are level, the moment the weight is removed the spring under the rails will force them up again and the converse will take place, and



AUTOMATIC AIR DOOR

the doors will close. The doors are of ¼in. plate stiffened round the edges by an angle iron frame; they are suspended in a racer which is bolted on to a timber frame work, and slide freely thereon by means of cast iron wheels working on the hangers of the doors. A turned pin is riveted to each door carrying a short link which connects the door to the opening lever; these levers are of wrought iron and are keyed to the short shaft by turned steel taper pins provided with nuts to render them absolutely secure. The rails are to be of the section shown, as they have to fit specially designed chairs, the short lengths cut to an angle at one end, and the long lengths having part of the bottom flange removed from one end. One end of the 3ft. length of rail rests in the special chair marked A, and the other end—the square end—rests in the lifting chair B; the square end of the 12ft. length rests in the lifting chair, and the other, or prepared end, rests in the chair marked E. All the gear may be left black except where there are working parts, and these must be accurately bored or turned. Castings are to be sound, and the iron of such quality that a bar 1in. square on supports 1ft. apart will sustain the weight of one ton. The wrought iron to be of the best Staffordshire, and capable of bearing a tensile strain of twenty tons.

DOCKYARD NOTES.

THE current *Rivista Maratima* publishes some photographs of the Spanish warships after Santiago that we do not remember to have seen before. An exceedingly important point—demonstrated very clearly by these photographs—is the immense amount of damage done by falling masts. Both in the Vizcaya and Oquendo the masts have fallen upon guns, in one case the heavy fighting top has completely smashed in a shield. Our Orlandos, our Royal Sovereigns, Edgars, all our second-class cruisers, stand to lose guns in action by the masts being brought down, and it is curious that no attention seems to have been directed to this matter. Of course, the Vizcayas, having all guns on the upper deck, were singularly liable to such mishaps, and it may be held to be singular ill fortune that, in falling, the masts should in every case have smashed a gun or two. But the fact remains that the abolition of "masts and yards" seems to have in no way lessened danger from aloft. It is not easy to point out a remedy, because masts are essential, and the modern tendency is to high ones, in order to facilitate signalling. The addition of extra masts to our Admirals, Niles, Sanspareil, Thunderers, &c., all shows that two masts are looked upon as an essential minimum. The Japanese, who ought to be authorities on the matter, carry three signal yards on the solitary mast of their Matsushima; the Italians have done the same with their one-masted ships, while their new designs revert to two masts. Abolition of the mast seems, therefore, out of the question. Splinter nets, and so on, are no use when a falling mast has to be encountered. A deck over the guns may afford the necessary protection, but a decked-in unarmoured battery will be put out of action by the smoke of the first shell that bursts in it. No doubt some improved form of stays might mitigate the danger of having the best part of a cruiser's battery put out of action because a badly-aimed shot chances to ricochet and hit the mast.

THERE is, of course, always the possibility that it was running aground which brought down the Spaniards' sticks; but it is always attributed to the American fire. It is certainly curious that the masts should have been brought down in such numbers at Santiago, while Yalu, though it proved the military top to be a death trap, only produced two shot-away masts—the Ting Yuen's and the gunboat Akaji's. But Yalu and Santiago are at variance in many things, and it is certainly a puzzle why three or four small shell should have fired the Spanish ships, while the old Chen Yuen at Yalu took four hundred hits without material damage.

ONE photograph of the Vizcaya's bow shows a very large hole on the water-line, the plates cracked for some considerable distance, and bent outward. This is on the starboard side, where, of course, the principal effect of a shell hitting the port side would be visible. The deck above is bulged right up. This is supposed to be the effect of a torpedo exploded in its tube, but it scarcely seems sufficiently destructive. On the other hand, it looks a very great deal for an 8in. shell to do. We referred some while ago to the fact that the Oquendo had her accommodation ladders down. The photograph of the Vizcaya exhibits the same thing, though most of the ladder had been burnt away. A mast fell on the after 11in. gun of the Vizcaya. In this case the shield looks to be unhurt, but the mast lies on the port side, so that the gun—which is in loading position—must have been rendered useless, the American ships being to port.

A MILD attempt to revive the war scare was made by a local paper at Portsmouth a day or two since, over an official intimation that the turtle backs of the newly-commissioned destroyers were not to be painted white, as has hitherto been done. While on the subject of Portsmouth, we may mention that the electric light station upon Southsea Common, deemed necessary for the proper supply of electricity to the search-lights on the forts, has been put up. It was a little while back the subject of much indignation on the part of some of the townspeople, who appear totally unable to understand that Southsea as a watering place is, and must be, purely secondary to Southsea as part of our chief naval base. The absurdest part of the agitation is that the common is War-office property. At the present time Clarence Pier blocks the fire of certain guns, and would have been demolished a year or more ago but for the frantic indignation of the local lodging-house keepers. But for the recent war scare the forts would probably have had to shift as best they could for electric lights. As it is, were war to suddenly break out, part of the defences would be useless in deference to the lodging-house keepers. In the recent Town Council elections a "party card" was opposition to the projected enlargement of the dockyard, because some small mercantile and purely local interests might be jeopardised thereby. At Devonport and Pembroke the same sort of interests are in evidence every now and again. The existence of these local sentiments is neither here nor there; the fact that the War-office is coerced in deference to them is an important matter, and a very bad sign of the times.

MR. RUDYARD KIPLING, in his recent impressions of the amateur afloat, improved upon Lord Wolseley's "pumping lead on an enemy," with "squirting death through a hose." Emile Duboc, in this week's *Le Yacht*, has gone one better. In the course of a really thoughtful article upon gunnery at sea, and the exceeding difficulty in fighting a bow gun in a sea way, he makes, in all apparent sincerity, the suggestion that the rolling boat for gunnery practice, recently devised by our Admiralty, might be further improved by the addition of powerful steam pumps, which should automatically discharge spray violently over the gunners. The idea sounds comic, but is of course sound enough, if looked at on the principle of simulating actual conditions. The article is illustrated by two photographs of the bow waves of the high freeboard Bouvines and the low freeboard of the Jemappes class, taken from the forebridge.

NEW WORKS AT BARRY DOCK.

No. I.

A PROMINENT feature in the proceedings of Section G, at the meeting of the British Association at Bristol in September, was the frequent reference to the Barry Dock by the President of the Section, Sir John Wolfe Barry, by many others, and more particularly by Mr. R. C. H. Davison in his paper on "New Works at Barry Dock," which was well illustrated by thirty-four lantern slides, and much of which is incorporated in these notes; but in addition to all this the directors of the Barry Railway Company were good enough to invite the members of the Association to inspect the new works, and a special excursion with that object in view was organised to visit the dock on the Saturday in the week of the meeting. In our reports of the meeting we stated that an account of that visit and of Mr. Davison's paper would follow in due course, and we shall now carry out the intention then expressed.

The programme of the excursion under notice was remarkably well arranged; moreover, each participant was handed an account and plan of the docks, as well as a detailed programme, recording no less than seventeen visits. This programme was systematically and punctiliously carried out, and the whole excursion proved most satisfactory.

The excursionists were conveyed from Bristol in two special carriages attached to the 9.45 South Wales train of the Great Western Railway Company, and on arriving at Cardiff at 11.20, were handed over to the Barry Railway Company, upon whose system they henceforth travelled. The route then followed may be gathered from plan Fig. 1. After passing Cadoxton Station the train slackened, and a view was obtained of some of the new works. In the near distance the new dock—Dock No. 2 on the plan—the new staiths and the new railway viaducts leading to them, whilst in the immediate vicinity were the extensive railway arrangements at the east end, the most prominent of these being the great field of siding accommodation that covers a great area, and is provided with a great number of sidings.

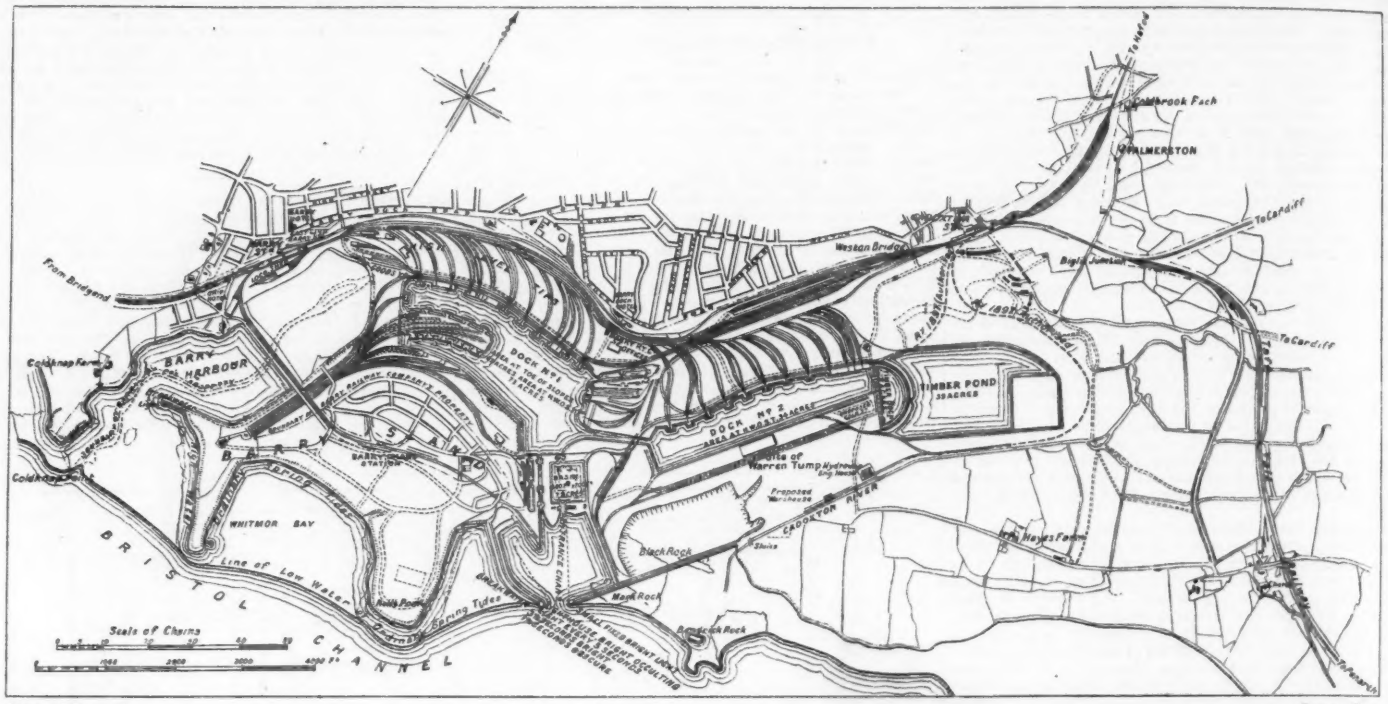
The main passenger line has been judiciously isolated, and has an embankment of its own, whilst another inclined embankment takes off the lines leading to the high-level viaducts which cross the low-level road at north of Dock 2 by a steel viaduct, supported on graceful masonry piers; the character of the viaduct work is set forth in Figs. 2 and 4. The train proceeded slowly, passing under the high-level viaduct, leaving on the right a graving dock at the east end of the main dock, and a graving dock in course of construction, and then by a semicircular curve on to the lower line on the quay level, which was followed to the north-eastern end, where the return was made in the reverse direction. This gave an opportunity of inspecting the viaducts, the staiths, and the great basin of Dock No. 2, Fig. 2.

The train was quitted at the temporary bridge at the end of Dock No. 2, Fig. 1, that crosses the junction cut, which connects the new with the older dock—Dock No. 1. Here there is a wrought iron sliding box caisson, with a hydraulically-lifting deck to carry the road and rail traffic; moreover, this caisson has two faces, and can take pressure on either side, so that the level of Dock No. 2 may be kept either higher or lower than Dock No. 1 at tide time; there, too, three larger sluice ways are provided with an area of 330 square feet. This was seen in operation, the deck being caused to descend; the hand rail at each side is mounted on hinged levers, and so quietly lies down during the descent until brought to the level of the deck. When the latter is lowered sufficiently to clear the arch, the caisson is hauled into its recess on the north side by chain and pulley gear actuated hydraulically. The whole worked with great smoothness and ease, and the return of caisson, the deck, and the hand rail into position was watched with eagerness by all assembled.

From the end of Dock No. 2, Fig. 1, an excellent view of the northern side of the new dock is obtained; it is reproduced in Fig. 2, and it will be observed what a fine display the long rows of stately staiths makes. For comparison we give a view of a corner of the old dock in Fig. 3, which shows fixed and movable tips arranged for working in conjunction, an arrangement that enables two or three tips to be discharging into two or three hatchways of a vessel at the same time, whilst Fig. 4 gives a closer view of a high-level tip and traverser. In these tips the lifting and tipping cylinders are placed at the side of the framing, and the well is done away with, a system that has been found safer and more convenient, and has been adopted in the fixed high-level tips of Dock No. 2. In the latter, however, the lift has been increased from the 37ft. and 42ft. above quay level that obtains in the old dock to 45ft., and consequently the height of the tip framework is 75ft. from the quay level, or just 121ft. 6in. above the bottom in Dock No. 2. In Fig. 4 the anti-breakage crane is seen in operation. It is used to lower the coal into the hold of a ship until a cone is formed, when tipping proceeds direct from the shoot. Fig. 5 shows a very small section of the vast operations that have been conducted in the construction of these docks. It represents the excavation in connection with the junction cut. It will be observed, that winch hand-cart bogey roads were used for the purpose; the ground was treacherous, and the utmost caution had to be observed to avoid accidents owing to the proximity of the main dock, and for that reason the original intention of using two sections of timbering, one to be built in the dry, and the other after the dam was removed, was abandoned, and the section in the dry was not carried towards the main dock as far as it was intended; instead, in one section of the cutting the work was conducted in 16ft. of water, and the dam next the main dock was thinned down as far as it was deemed safe. The water was then raised to the same level as that in the main dock, the top of the dam carted off into wagons, and then dredging started. The water for filling the junction cut and Dock No. 2 was drawn by a 15in. syphon from the main dock, in the latter case passing through the caisson gate sluices.

Figs. 6, 7, 8, 9, illustrate the character of the ground worked in, the method adopted, magnitude of the operations, and the dimensions and character of the timber structure in the junction cut. Fig. 6 shows a cross section of the work carried out nearly as originally conceived, with pitched sloping sides passing under timber jetties which extend along each side, with gangways to the shore. The excavation was stepped and filled in with dry filling, then faced with stone blocks, and the timber structure was of the best, as set forth in Figs. 6 and 7, rising 45ft. above the bottom of the cut, and 5ft. above high-water level of ordinary spring tides, and 13ft. above high water of ordinary neap tides, the width at the base being 28ft., and at the top 16ft. 2in. When the water trouble ensued the operations had to be modified, as shown in Fig. 8, that is, the pitching slopes terminated at a higher level and stone filling was used with sheet piles; whilst at the main dock a further modification was introduced, as set forth in Fig. 9, when stone filling had to be adopted to a much greater extent, and the subaqueous portion of the structure was faced with rubbing pieces, and the width at the top increased to 26ft.

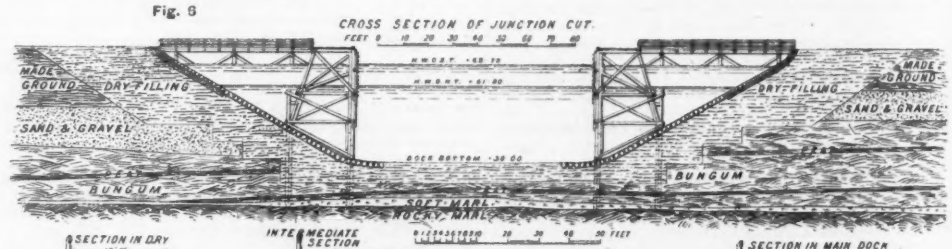
The junction cut is 1000ft. long, 130ft. wide at the main dock, narrowing to 80ft. at Dock No. 2, where it passes through a masonry passage in which the caisson already referred to is situated. Dock No. 2 is a fine sheet of water, with an area of 34 acres; the site has been almost entirely reclaimed from the foreshore. The northern side, to which we have already referred, has ten high-level fixed tips and two high-level traversers—Figs. 10 and 11—the tip towers upon which the tips

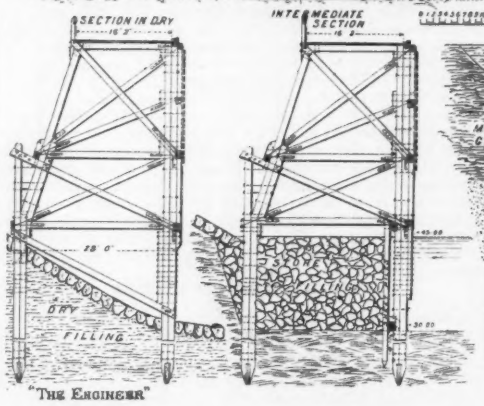


"THE ENGINEER" SWAIN ENG.

Fig. 1—PLAN OF BARRY DOCKS

Fig. 6

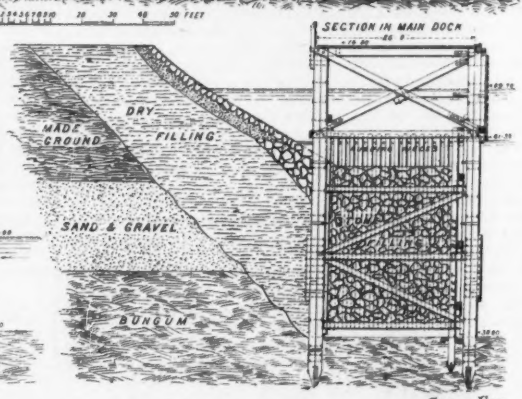




"THE ENGINEER"

Fig. 7

Fig. 8



SWAIN ENG

Fig. 9

stand are 300ft. apart, and are of masonry, as is clearly seen in Fig. 2, whilst the intermediate wall either slopes as shown in Fig. 10, or is built as shown in Fig. 11, wherever a good foundation could be obtained, as at the eastern end. The tip towers rise to the quay level 45ft. above the bottom of the dock, and project, as will be seen, some distance beyond the line of dock; this is to enable vessels to scarf, and that is when the bow of a vessel at one tip can lie inside the stern of the vessel at the next tip, and so on.

The tips or staiths are steel structures rising 75ft. above the quay level, and are provided with a lift for adjusting the height of the wagon, with tipping appliances, with two shoots, one for loading into the ship and one for loading small coal into coal wagons, and an anti-breakage crane, as shown in the figures. Moreover, all tips are provided with two weighbridges, one on the full and the other on the empty road. Each tip is capable of lifting 20 tons, and the lifting and tipping cylinders may be seen on the sides in Figs. 10 and 11. In the former the lift is at the top, 45ft. above quay level, whilst in Fig. 11 it is 25ft. 9in. above the quay. This is also the rail level of the high-level tips, and is 36ft. 9in. above the average level of the water in the docks, which, too, is the level at which most of the coal is tipped, therefore the wagons require less lowering or raising than with any other rail level. The approach sidings for the full wagons, run down towards the tip on a gradient of 1 in 233, and the empty wagons run off into a tip on a gradient of 1 in 70, and are drawn out up a gradient of 1 in 45.

The twelve tips in the new dock are all high level, and there are two traversers; whilst in the old dock there are eleven high-level fixed, one traverser—shown in Fig. 4—one radial, eight low-level fixed, three low-level movable. About their capacity we shall have something to say later on.

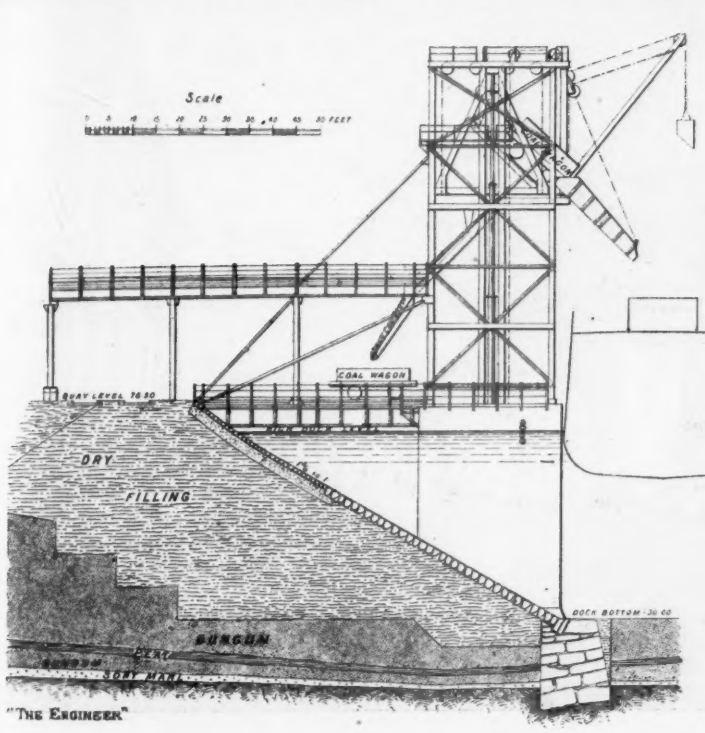


Fig. 10

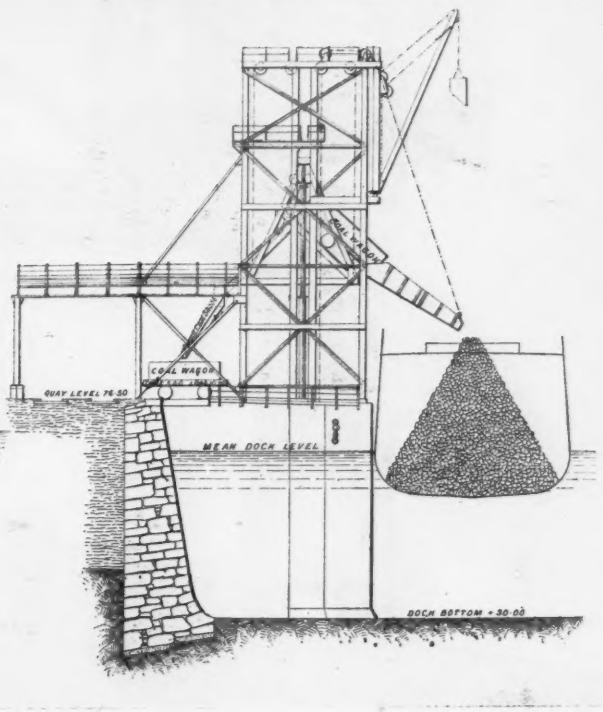


Fig. 11

COAL TIPS, BARRY DOCK

DEFENSIVE WORKS IN PROGRESS AT GIBRALTAR.

IT is satisfactory to learn that the new works, which were sanctioned by Parliament, for the extension of moles and dock accommodation at Gibraltar, as well as for the strengthening of the land defences of "The Rock" itself, are progressing with the utmost rapidity. Several thousands of Spanish workmen have been employed during the spring and summer, most of whom live at Linea and other places outside the gates, and are shut out after gun-fire in the evening. It is somewhat unfortunate having to employ these Spanish artificers and labourers, whose intimate knowledge of the interior features of works and batteries might, in the event of hostilities, supply a host of intelligent spies, who could afford valuable information to our enemies. Attila, King of the Huns, is said to have slain, wholesale, the workmen whom he employed in the erection of works whose nature it was desirable to retain a secret. We cannot follow his example; but it does seem to us a somewhat paradoxical arrangement to employ a quantity of foreign Europeans on works which are of such confidential character that Mr. Goschen himself had to obtain special sanction from the Secretary of State for War to visit them, whilst inspecting the progress of naval operations at Gibraltar. Indian coolies could do the business quite as well as Spaniards; and the money which was spent would thus return into the pockets of those who were at least subjects of the Empress Queen. As it is, it all goes elsewhere. When we speak of the "confidential character" of works, we do not, of course, allude to moles and breakwaters or docks, which possess no such attributes; but we learn that Spaniards have been employed in constructing the batteries and gun positions of a masked character, which are found scattered over the entire surface of "The Rock," from the North Front to Europa Point.

The "drift" which has been cut through the rock from the western side, where the bay is situated, to a spot near Catalan Bay on the east, is practically a tunnel large enough for locomotives and trucks to run through, and several engines are actively employed in it, which convey stone and sand to the mole extensions and docks. By this means a vast quantity of material is being brought from quarries on the eastern side, and from the sand slopes, which descend at a sharp angle from the foot of the scarped precipices beneath the signal station to the Mediterranean shore, right through the rock to the bay, for conversion into great blocks of béton and mortar, also for the erection of walls and other masonry buildings. These sand slopes are practically inexhaustible. They are composed of fine silicious material, clouds of which are blown off shore and intercepted by the steep face of Gibraltar rock—1350ft. high and 3¼ miles long—during the prevalent "Levanter" winds. Most of the old works at the North Front, which is a huge triangular face of rock 1300ft. high, facing the neutral ground, and surmounted by the old "Rock Gun Battery," are dismantled; and the famous long galleries cut through the solid rock, the highest of which terminated in a lofty hewn cavern called St. George's Hall, are now, alas, so far as military potency is concerned, works of a past age, and practically of little value. The King's, Queen's, and Prince's lines, which can be seen cutting sharp "straight-edges" out of the solid rock away on the left flank of the land-port gate, as we enter the fortress, are fitted for machine guns and small quick-firers, whilst a heavy battery of modern breech-loading guns occupies a position with high command near the old Moorish castle.

The Orange Bastion, King's Bastion, Jumper's Bastion, and other splendid works along the line wall, once terrible with their 32 and 68-pounder old smooth-bore pop-guns, which would rattle their spherical shot and shell harmlessly against the thinnest of modern armoured vessels, are at last made useful as affording excellent emplacements for 6-pounder Hotchkiss and 12-pounder quick-firing guns, the latter being fitted with ample steel revolving shields 4in. in thickness. But the best piece of work which has been recently done is the cutting out of a wide cart road, strong enough for the transport of the heaviest guns, and contrived to be at a gentle gradient, comparatively, right up to the signal station, to O'Hara's Castle, or rather to the site of it, and towards the "Rock Gun." By the aid of this new road a series of heavy masked batteries and separate gun positions has been constructed right along the slopes on the western side of the ridge, which runs from north to south. Some of these are grouped around the time-honoured site known as the "Rock-gun Battery," dominating the North Front, where the two boys, called "Shot" and "Shell," were, according to Drinkwater's "History of the Siege," accustomed to sit and watch for the firing of mortars from the Spanish lines at Linea, giving notice by means of flag signals to the people in the town below, so that they might seek shelter from the coming projectiles. An especially powerful battery is mounted at the signal station, which will give ample cover to the exit from the "Drift," on the Mediterannean side, when it is required to be under gun protection. Towards O'Hara's Castle there are numerous groups. It is obviously inadvisable to give any particulars as to the grouping and nature of guns which occupy the several masked spots, but it may be mentioned that both 9·2in. and 6in. breech-loaders are there in large numbers, and that every group has its separate and masked position-finding cell and instruments, ranging up to 14,000 yards, some of the instruments at a high altitude being of the "depression" type, an almost unvarying base being obtainable at Gibraltar, as there is hardly any rise and fall in the tide.

The old batteries of 38-ton guns—muzzle-loaders—on the Alameda and over the town of Gibraltar, as well as at Europa, are still, we understand, to the front, but the two 100-ton muzzle-loading guns, which had developed serious defects some six or seven years ago, are now, we are glad to say, replaced by two efficient weapons, which are mounted on the same spots, near the town and at Europa.

Two of the latest 9·2in. guns are also, we learn, now in course of being mounted at Europa Point. They are 445¼in. in length, or 48·4in. calibres. Their breeches are opened and closed by and with a balanced spindle, having a large steel ball opposite to the lever handle, in a far easier and more simple manner than the earlier 9·2in. breech-loading guns. One man can work the breech with ease. They are, of course, of wire or steel tape construction. The weight of the projectile is 380 lb., and the muzzle energy 19,220 foot-tons. The range of these guns, if sufficient elevation be given to them, is very great. The artillery officers in charge of them at Gibraltar believe that they will effectively command the entrance to the Straits almost across to Ceuta.

Another very important item has been constructed. The water supply was found to be very insufficient, and a tank containing sufficient water for the entire garrison, and for the normal population of the town—those born on the rock—for a sustained siege, has at length been contrived in a hollow behind the town, which fills itself naturally, owing to artificial watersheds having been scarped along the faces and slopes around this hollow. This water has hitherto escaped into the hollows and recesses of the rock, such as St. Michael's Cave.

We learn that excellent arrangements have been made for the construction of secure and indestructible magazines for powder and explosives of various kinds. This is, of course, comparatively easy in a station such as Gibraltar, where you have only to blast out a hole to obtain a shelter that no hostile shot or shell can ever reach. But singular to say, for more than a hundred years the magazines of Gibraltar were mere houses of thick masonry, with—so-called—bomb-proof roofs. It is needless to say that no indication can be given in this article as to where the new magazines are situated. Unhappily, however, the site is well known to some three or four thousands of the descendants of Pizarro and Almazio.

CATALOGUES.

J. Tylor and Sons, Limited, London and Sydney. Sanitary Appliances, Water Meters and Fittings, Pumping Apparatus.—This is a handsomely appointed book of nearly 400 pages, with nicely executed woodcuts, and the articles are priced throughout.

Browett, Lindley, and Co., Limited, Patricroft, Manchester. Illustrated pamphlet on the Beytrup Inertia Automatic Shaft Governor.—This appliance, we are informed, is used very largely in the United States, and Messrs. Browett, Lindley, and Co. have acquired the rights to manufacture and sell in Great Britain.

Vandam and Co., Westminster, S.W.—This is a handsomely appointed catalogue of electric light fittings. The electroliers show more than the average amount of taste in design. Why should not the wall fittings, such as switches, claim a little more attention in this direction?

J. C. Lyell and Co., Victoria-street, London, S.W. Illustrated price list of de Laval "Svea" glow lamps.—This pamphlet also describes the process of manufacture of incandescent electric lamps, which will be read with interest by many.

Ward and Goldstone, York-street, Manchester. Price list of insulated high conductivity copper wires.

The General Electric Company, Limited, London. Circulars giving illustrations, and particulars of the "Carsak" battery. In this battery the negative is a porous cell containing the necessary proportions of carbon and manganese granules packed together and held in position by a cylinder of sacking. The positive is a zinc cylinder.

ELECTRIC CRANES OF THE SOUTHAMPTON HARBOUR BOARD

MESSRS. STOTHERT AND PITT, BATH, ENGINEERS

THE ELECTRIC CRANES OF THE SOUTHAMPTON HARBOUR BOARD.

In 1893 the Southampton Harbour Board put two electrically-driven three-ton cranes on the Town Quay at Southampton. These cranes, which were supplied by Messrs. Statter and Co., with Messrs. Stothert and Pitt as sub-contractors, and which were described by us in our issue of the 28th June, 1893, have been found to work exceedingly well; so well, indeed, that when the occasion arose for more crane power it was decided to make the new cranes electric also. Four new cranes, illustrated above, were accordingly ordered, and their official trials took place on Thursday, the 3rd ult. The new cranes have been supplied by Messrs. Stothert and Pitt, as principal contractors, from the designs of Mr. J. G. W. Aldridge, the consulting electrical engineer to the Harbour Board, who also designed the original cranes.

The trials were eminently successful, and as the new cranes present many novel features, we propose describing them in detail. The installation, consisting as it now does of six electrically-driven travelling jib cranes, is certainly unique as far, at any rate, as the United Kingdom is concerned.

The original cranes were three-ton cranes, and so are those recently erected, but as it had been found in practice that the average load to be lifted was rarely more than 30 cwt., it was decided that the new cranes should be so arranged that they could raise that load with a single rope at the rate of 200ft. a minute, or three tons with double rope at half that speed. The rate of lift of the 12-ton crane is 15ft. a minute when fully loaded, and higher proportional rates with smaller loads.

One of the new cranes is capable of lifting 12 tons, and is, as will be seen later, and by consulting Figs. 1 and 2, of slightly different construction to the others. They are all of the fixed jib type, and are mounted on travelling carriages which run on rails of 14ft. gauge, and have a headway of 14ft. 6in., thus affording ample clearance for a locomotive and carriages to pass beneath them. The travelling motion is not imparted electrically, but by hand. The reason for this is obvious when it is considered that for unloading a ship of such size as comes to the Town Quay at Southampton, the hold might be entirely cleared without once moving the crane.

All the electrical gear has been supplied by Messrs. Siemens Bros. The motors used for lifting are 50 brake horse-power of the two-pole shunt-wound type, and any part of either of them is interchangeable, with a corresponding part in any of the others. They run at 600 revolutions a minute, and their electrical efficiency is about 91 per cent. at full load. On the shaft of each of them, for the three-ton cranes, is keyed a three-threaded steel worm, which engages with a Delta metal worm-wheel, and the power is communicated by means of a Lindsay coil clutch to the winding drum, which is of cast iron, carried by cast steel side frames. The lifting motors are the same size, whether for the three or 12-ton cranes, the difference simply appearing in the rate at which the loads are lifted, but in the case of the 12-ton crane the motor is reversible, whereas in the three-ton cranes it is not, and the power is transmitted to the drum by means of spur and pinion gearing. The operating mechanism is extremely simple, there being only one lever for lifting and a wheel for slewing. The change from a 12-ton to a three-ton lift in the case of a 12-ton crane is brought about by means of a lever, and the whole operation takes less than a minute,

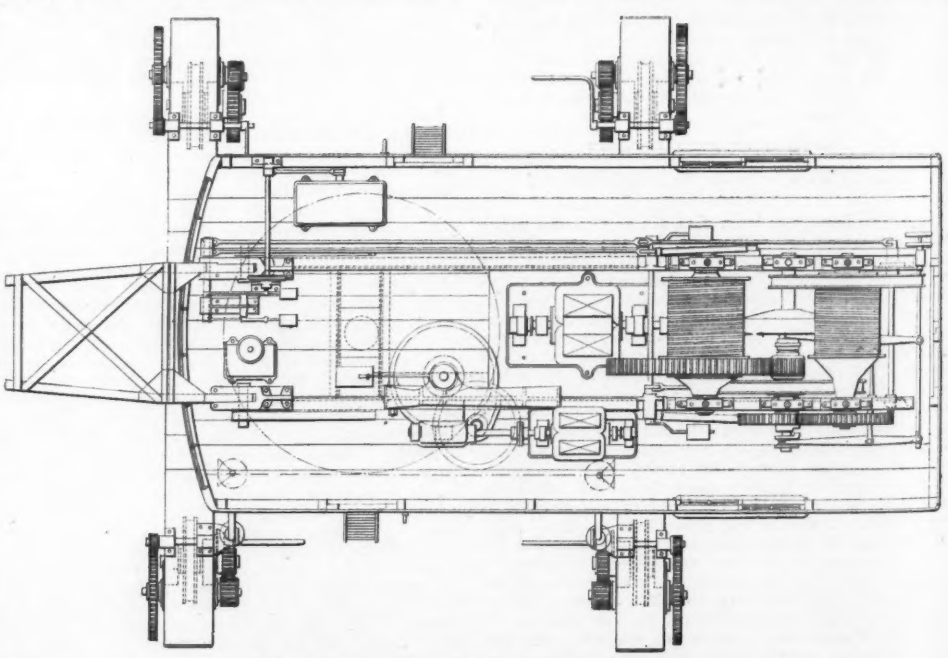


Fig. 1—CABIN ARRANGEMENTS OF 12-TON CRANE

there being two separate drums, either of which is put into gear as required. In this crane there are two wheels at the head of the jib, one for the three-ton rope and one for the 12-ton rope, the former situated at a radius of 30ft. from the centre of the crane, and the latter at a radius of 27ft. The controllers for operating the motors are a special device of Messrs. Siemens and Halske, of Berlin, and are exactly suited to crane work, being fitted with carbon "breaks" and magnetic blow-outs, but they are distinctly cumbersome, and in this direction we hope soon to see some improvement.

A special safety signal device, the mechanism of which we illustrate, Fig. 3, is well worthy of mention. By its means, and through the compression of a spring, an electric bell is rung in the cabin when the load exceeds the maximum, and thus warns the operator to cut off the current before damage is done. We may mention that the designing of this device was rendered necessary by the fact that when the original cranes were installed in 1893 the dock labourers, fearing lest they would take their work away from them, did all they could to ruin them, going so far as actually fixing the hook of the crane on to the coamings of the hatchway or any other fixed part of the boat; on one occasion an armature was

burnt out in consequence. It is interesting to note that, in spite of the fears of the dock hands as to their work being taken away, the cranes have brought so much more work to the quay, that more hands than ever are now employed.

There are two kinds of brakes used, the first being of the ordinary band type fitted with wooden blocks, and actuated by foot levers. They are sufficiently powerful to hold suspended any load which the cranes are capable of lifting. Ratchet-and-pawl arrangements are provided for use when the foot pressure is taken off. In the larger crane there are large and small bands for heavy or light loads. The second kind of brake is electric, and it comes automatically into play, and holds the load should the current for any reason cease when lifting is in progress.

Each crane is provided with a 10-H.P. motor for slewing, which is entirely distinct from the lifting motor, but like the latter they are shunt-wound two-pole machines, and are reversible in motion; they are provided with worm gearing which actuates the pinion, which in its turn works in a toothed wheel attached to the top side of the under frame. The three-ton cranes can slew a 30 cwt. load at the rate of 400ft. per minute, at a radius of 30ft., while the larger size fully loaded can make a complete turn in about a minute, or at the rate, with a 27ft. radius, of some 85ft. per minute. All can slew and lift or lower at the same time. The cabins are provided on their underside with a number of small wheels, which run on a table on the top of the under frame.

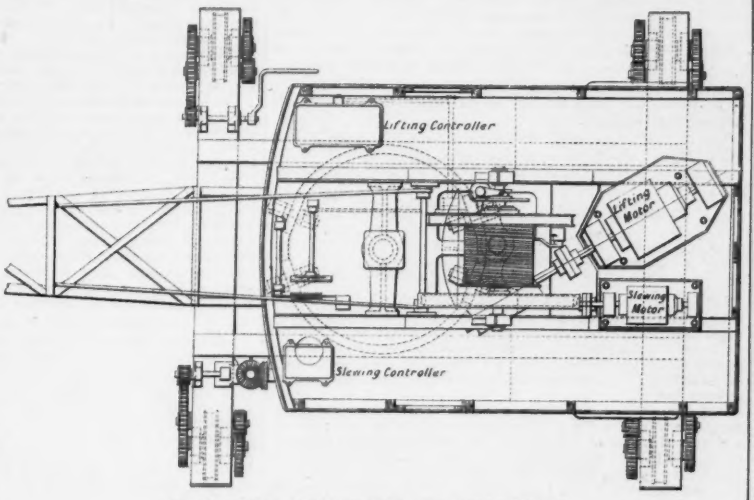


Fig. 2—CABIN ARRANGEMENT OF 3-TON CRANE

The current is obtained from the Corporation supply at a pressure of 200 volts. The electric mains run the whole length of the Town Quay, and at intervals of 40ft. there are cast iron boxes, the lids of which can be fitted with a wide-lipped pipe, through which a flexible concentric cable coming from the crane makes connection with the mains, a sufficient length being provided to allow for alteration in the position of the cranes up to 20ft. Any further movement necessitates changing to another box; but, as previously explained, only small movements are, as a rule, required when once work on a ship is started. The flexible cable ascends to the centre pin of the crane, and here the current is taken off by specially designed rubbing contacts and led to the switch-board, which is provided with instruments, fuses, &c.

The general efficiency of the cranes, which is 55 per cent. of the power given to them from the electric mains, is a figure which reflects the highest credit on Messrs. Stothert and Pitt and Messrs. Siemens Brothers, as well as on Mr. Aldridge.

With such cranes as these before us, it would seem as though a heavy blow was being struck against hydraulic machinery for dock and quay work, especially in those places where the electric lighting installation is in the same hands as the dock or quay. Southampton has its electric lighting installation. This at the time the original cranes were supplied was in the hands of a company, but it has now been acquired by the Corporation, which consequently derives the benefit of a day load from these cranes—a great desideratum in an electric lighting station, which is forced to be always at work, no matter what its load is—and power is thereby considerably cheapened. Moreover, in electric cranes, provided the mains are in good order—and the lighting authorities will, no doubt, see to this strictly—there is no waste, and the current used is in proportion to the load lifted; whereas, if hydraulic machinery be employed, the amount of water used is always the same, no matter what the load. A factor of no inconsiderable weight, too, is that with electricity there is no fear of frost putting an end to operations; and as regards working, one sort of crane is equally as easy as the other. We have already called attention to the small number of actuating levers, &c., and it is worthy of note that it does not require a man with electrical knowledge to drive the cranes; indeed, during the period between the time when the cranes were erected and the time they were tested, two in particular were worked fairly hard. One, driven by a man knowing nothing of electricity, gave no trouble whatever; while the other, driven by an experienced electrical fitter, gave trouble for a time.

We certainly think that the Southampton Harbour Board are to be congratulated on the step they have taken in installing electric cranes, and we are watching the result with considerable interest. For instance, we should much like to get at figures as to cost of running, cost of maintenance and repairs, &c., and we shall hope some day to have them. Meanwhile it would seem as though the Southampton Harbour Board authorities were perfectly satisfied as to what the result will be, as we hear that two further electrical cranes are shortly to be ordered.

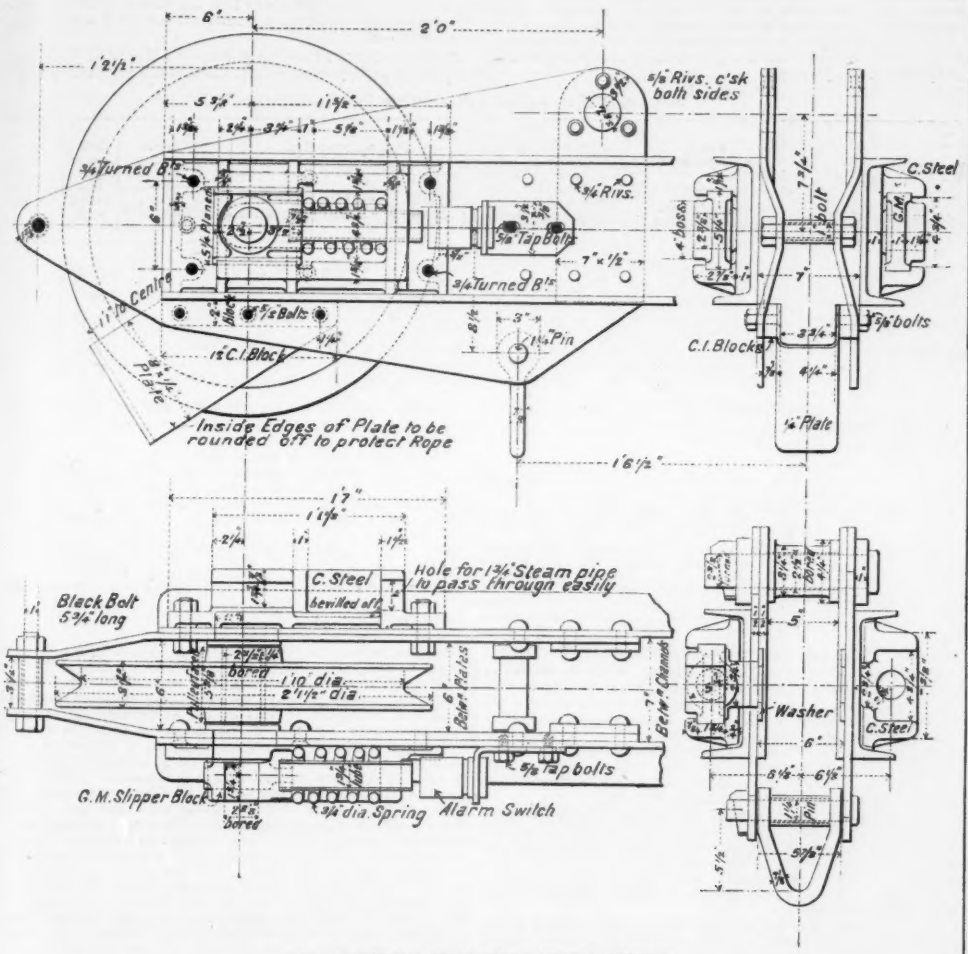


Fig. 3—DETAILS OF SAFETY SIGNAL DEVICE

We hear that Messrs. Siemens Brothers have received an order for the electrical plant for the Cardiff Corporation Electric Lighting Station, which is to be erected at once.

THE LOSS OF THE MOHEGAN.

THE loss of the steamship Mohegan remains a mystery. After five days devoted to careful and exhaustive investigation, the Court of Inquiry has not only failed to solve the problem on any single point, but has rather added to the darkness by showing conclusively that of the various causes which might have led to the disaster, not one of those advanced can be supported for a moment. The ship was in good and seaworthy condition; she was fully provided with compasses; the compasses were properly adjusted, and unaffected by electric currents; her master was sound in body and in mind; and an ample watch was set. Nevertheless, in the dusk of the evening, with the land still faintly visible, the vessel got so far out of her true course that before it was possible to save her she struck upon the Manacles. Within a few minutes she took a heavy list to port, and in less than a quarter of an hour ceased to float. At the same time the electric light failed, and the lamp room being flooded, it was impossible to obtain oil lanterns, and the list to port, on which side the socket was fitted, rendered it difficult to discharge signal rockets effectively. Amongst the answers to the many questions which the Court set itself, there is not a single reply which throws the least ray of light on the mystery, unless the self-evident fact that a mistake was made in holding the vessel to a north by west course after passing the Eddystone is to be regarded as such. From an engineer's point of view there is little or nothing to be said. The efficiency of the steering gear or of the engines has not been for a moment in question, and the only points of engineering interest which have been raised are, first, as to whether the electric mains or dynamo could have affected the compasses, and, secondly, as to the sudden failure of the electric light, which undoubtedly added greatly to the magnitude and terrors of the catastrophe. The first point has been satisfactorily answered by the Court. The vessel was steered by a Thompson compass on the upper bridge situated 100ft. from the dynamos, and she was wired on the double-wire system, so that it may be regarded as certain that the compasses were unaffected by the electric plant. The second point is of far greater importance. It raises the objection of old standing against the electric light, that the interruption of the current may be brought about by a slight cause, and that from the nature of the system failure at one place may mean a failure throughout. It is somewhat strange that although there are few big buildings which depend absolutely and solely on electric supply for their illumination, vessels, which rely in no small measure for their very safety on their lights, should run the risk of being plunged into darkness even momentarily. It is true that the Mohegan carried oil lamps, but as far as we can gather from the inquiry, although they were in readiness, they were not lighted at the time of the accident, and it may be assumed that it was not the practice of the ship to keep some oil lamps always burning. There can, then, be no question that the Court did wisely in recommending "that where a vessel is lighted with electric light she ought at night always to have lighted, and in an easily accessible position, oil lamps to take the place of the ship's lamps in case of failure of the electric light."

THE LAW ON SMOKE CONSUMPTION.

SINCE referring in our issue of the 18th ult. to the question of smoke consumption, an important decision has been rendered that is of special interest to steam users throughout the metropolis. The fact may be remembered that, apart from the difficulty of procuring supplies of smokeless coal during the prevalence of the dispute in South Wales, in all cases where a substantial defence was made to summonses taken out for the abatement of alleged nuisances, reliance was placed by boiler owners upon that particular section of the Public Health (London) Act, which ordains that the furnaces shall be constructed to consume their own smoke. Though this defence has held good and been the means of either postponing legal proceedings or of deferring convictions in various cases, it would appear from the recent decisions of Mr. Slade, at the Southwark Police-court, that such a defence is untenable, and is no excuse whatever for the emission of black smoke. These decisions, one of which was referred to in our issue of the 18th ult., appear to be based upon another section of the Act, thus showing that whilst the Vestries and manufacturing firms and engineering works have been depending upon one part, the London County Council relies upon another part of the Act. According to these decisions no regard need be had to the appliances in use for the prevention of smoke or the expenses incurred in fitting up such apparatus, the existence or non-existence of a coal strike, or other similar considerations. The law is, as laid down by the Southwark stipendiary magistrate in the two cases in question—and notices of appeal have not been given—that a smoky chimney, as such, is a nuisance, no expert evidence being required. As a result of these decisions the Vestry of Lambeth is now initiating proceedings against one company, whilst the works of two others are under further observation. The findings of the Southwark magistrate, where the London County Council has for the first time been successful in its crusade against the smoke nuisance, have now emboldened the Public Health Committee of the Council to again look about in other districts. Legal proceedings are being threatened in two cases in the parish of St. George, Hanover-square, and in one instance on Bankside, whilst the sanitary authorities in other districts are being urged to deal with a number of cases of alleged smoke nuisance. It will be obvious from the foregoing that a bad time is coming for offenders in the event of the Southwark decisions being confirmed in other Courts, and the prospect is rendered more unsatisfactory by reason of the intention of the County Council to endeavour to secure an amendment of the law so as to more effectually grapple with the smoke problem in the metropolis.

YORKSHIRE COLLEGE ENGINEERING SOCIETY.—At a meeting of this Society held on November 21st, Mr. J. H. Wicksteed, the President, occupying the chair, Mr. Edwin E. Whitehouse, M.I.M.E., read a paper on "The Testing of Materials." Samples of iron and steel had been kindly lent for inspection by the Kirkstall Forge Company, Limited, the Leeds Forge Company, Limited, the Leeds Steel Works Company, and the Monkbridge Iron and Steel Company, Limited. An interesting discussion was taken part in by Messrs. Wicksteed, Horsfall, Hepworth, Cridlan, Goldsack, Gilpin, and Adams.

THE LIVERPOOL TRIALS OF HEAVY MOTOR VEHICLES.

We have received a copy of the judges' report on the trials of motor vehicles, which were carried out under the auspices of the Self-Propelled Traffic Association in the neighbourhood of Liverpool in May last, and which we briefly described at the time. The trials, it will be recollected, were organised with the object of arriving at a type of heavy motor vehicle suitable for trade requirements in Liverpool and neighbourhood which should be capable of replacing horse haulage and of competing with the existing railway rates. Three money prizes were offered of £100, £75, and £50, and the trial runs and the competition were divided into two classes—one for vehicles capable of carrying a minimum load of two tons, and the other for a minimum load of five tons. The average speeds on the runs, inclusive of stoppages, were not to be less than six and four miles an hour respectively. There were other conditions with which we are not immediately concerned. Out of the entries received four vehicles, all propelled by steam engines, put in their appearance to compete, viz., a lorry to carry two tons, made by the Liquid Fuel Engineering Company, Limited, East Cowes, Isle of Wight—second prize—two lorries to carry respectively five and three tons, made by the Steam Carriage and Wagon Company, Limited, Chiswick—third prize—and a vehicle to carry four tons, constructed by the Leyland Steam Motor Company, Leyland—first prize. Although the general features of these vehicles have previously been described in these pages, a brief recapitulation will render the figures given more intelligible. The Lifu—No. I.—lorry was 16ft. 2in. long by 6ft. 6in. wide over hubs; wheel base, 10ft. 7in. longitudinally, and 5ft. 9in. centre to centre of tires transversely; platform, 10ft. long by 6ft. 5in. wide, giving an available area of 62 square feet. The boiler is of their well-known oil-fired, water-tube type, having 80 square feet of heating surface, and said to be capable of making sufficient steam to supply an engine indicating 25-horse power without forcing. The engine, of the compound reversing type, runs at 600 revolutions per minute for a speed of eight miles per hour, and is geared down from 8 to 1. Power is transmitted to the driving shaft by bevel wheels, the countershaft carrying the compensating gear, and having steel pinions on each end engaging with large steel internal gear wheels fastened to the spokes of each of the rear wheels. In this type of vehicle there is no changing of gearing for different speeds, the regulation being effected by means of the high-pressure cylinder steam valve, as when extra power is required high-pressure steam is admitted to the low-pressure cylinder.

The heavy Thornycroft lorry, No. III., is six-wheeled and articulated, the rear portion being attached to the front by means of a turntable, which allows of motion in two planes. Its dimensions are 25ft. 2in. long, 6ft. 6in. extreme width; wheel base of trailing lorry, 11ft. 1in. longitudinally, and 5ft. 9½in. centre to centre of tires transversely; platform, 17ft. 10in. long, and has 110 square feet of available carrying space. The boiler, of the well-known Thornycroft type, weighs 6½ cwt., has a heating surface of 65 square feet, and uses steam coal, the fire being forced by a fan driven by the engine, but capable of being worked by hand when lighting up. The engine is of the horizontal compound pattern, having cylinders 4in. and 7in. diameter by 5in. stroke, the condenser is placed on top of the cab, and weighs 2¼ cwt. Two-speed gearing is provided, so that the engine makes nine to twelve revolutions to one of the driving wheels, and power is transmitted from the centre shaft to the driving sprockets by chain gearing. The lighter Thornycroft, No. IV., vehicle is 16ft. long by 6ft. 6in. wide; wheel base, 7ft. 2in. longitudinally, and 5ft. 5½in. centre to centre of tire transversely; the platform has 60 square feet of available surface. The engine, boiler, and condenser are similar to those of the heavy vehicle.

The leading dimensions of the Leyland lorry, No. V., are: Length, 17ft. 9in.; extreme breadth, 6ft. 5in.; wheel base, 10ft. 2in. longitudinally, and 5ft. 7in. centre to centre of tires transversely; platform, 12ft. 7in. long by 5ft. 10½in. wide, and has 74 square feet available surface. The boiler is of the liquid fuel fire-tube type, having 110 square feet of heating surface. The condenser is situate in the top of cab, and weighs 95 lb. The engine is of the compound vertical type, and gives 14-brake horse-power at 500 revolutions per minute and 200 lb. pressure. The cylinders are 3in. and 5in. diameter, and the stroke 6in. Spur gearing is used to transmit power from the engine shaft to the first countershaft, reversing being effected by a clutch; chains are used for transmitting motion between the first countershaft and the differential gear and the wheels.

The arrangements made for carrying out the trials were of the most complete character. The chief incidents of the first day's run of 35·6 miles were the rapid travelling of No. I., tire troubles with Nos. III. and V., and a split boiler tube with No. IV. In fact, it was apparent already that the wheels and tires were not sufficiently strong for driving on bad roads. On the second day No. III. did not compete. The running presented generally similar features to the first, the wheels of all the wagons showing the result of the severe tests. The course taken was the reverse of that on the first day. The third day's run was over an alternative route, measuring thirty-six miles of somewhat improved road surface. On this occasion Nos. I., III., and IV. went over the course, No. II. being temporarily incapacitated by wheel defects. No. I. during the previous night had been fitted with a new low-pressure cylinder cover. No. III., after the experiences of the first day, proceeded at a much slower speed with a somewhat smaller load, the tires having been repaired. Progress was delayed by the necessity for frequent extra stops for supplies of water owing to the condenser not working up to its estimated efficiency. The fan belt, too, proved troublesome, having become charred. Vehicle No. IV. covered the course without special incident, but at a lower speed than previously owing to the possibility of further tire defects developing themselves. The fourth and last day of the trial runs was taken part in by all the vehicles. No. I. maintained the good speed before mentioned, but during a portion of the journey oil vapour incompletely burned was emitted from the funnel, and the result of the varying degree of combustion is shown by the slightly increased fuel consumption. No. III. developed a leaky boiler joint, causing a reduced pressure of steam, which told against the vehicle's hill-climbing capabilities. No. IV. suffered again from a boiler-tube failure. No. V. made excellent running, but the oil burner went out through the emptying of the oil tank. This having been re-charged the wagon proceeded, while just at the close of the run the inlet pipe to the condenser broke off.

The fifth day was set apart for manœuvring trials. No. V. essayed the trial first, and went through in very good style. No. I. was at a disadvantage by reason of its long wheel base, but got into position after a number of attempts. No. III. proved practically hopeless in the attempt to get its entire length parallel with the wall, and occupied over an hour before anything approaching the correct position could be attained, owing to the construction of wheel base on six wheels involving two centres of locking arrangements. No. IV. had considerable difficulty in getting in, which was evidently owing to lack of experience on the part of the driver since its short wheel base allowed it to come right out. It was evident, says the report, that, apart from structural differences, the successful manœuvring of the vehicles varied with the experience of those in charge. All the competitors chose to back into the embayment, much as carters are in the habit of doing, but there appears no reason why motor vehicles should follow this practice. Unless it is found practicable to propel the steering wheels of motor vehicles, it is probable that this particular manœuvre will continue to prove slightly more tedious in its performance than with horse-drawn vehicles.

The costs of working the vehicles are gone very fully into in the report, much more so than our space will allow of. They are worked out under three sets of working conditions, viz.:—

Distance Traversed per Day of Ten Working Hours.

	Laden.	Unladen.
A. ..	35 miles	Nil
B. ..	(Commercial speed) × 10	,,
C. ..	(Commercial speed) × 5	(Commercial speed) × 5

(A) and (B) are intended to correspond with what should be realised in a service between points where a full load can be provided in both directions, as in certain cases of work done between ship's side and a warehouse, two mills or warehouses, or in any organised haulage system, whilst (C) is probably the worst average of the light-load contingency that would be likely to continue even in town cartage.

The commercial speed differs in several features from the actual running speed, also from the mean speed between the point of arrival and point of departure. The total distance traversed, divided by the net time occupied in actual running, gives the speed which must be considered in relation to the legal limit of five miles per hour for vehicles Nos. I, IV., and V., and of six miles per hour for No. III. We have also analysed the speeds between many of the numerous timing-points, and have paid due regard to uniform running in our conclusions as to the capabilites of the several vehicles. The same distance divided by the whole time occupied in going round the courses gives the mean speed. This would be the true commercial speed, but for some exceptional delays caused by circumstances that would be unlikely to recur more than very occasionally, *e.g.* the failure of a boiler tube; or that would be entirely absent from the working day of a vehicle in actual service, *e.g.* a stoppage for luncheon.

The commercial speeds have been obtained from the observations and records of the actual performances of the vehicles during the trials, by deducting all delays that arose from causes which would not hamper their working on business lines. On the other hand, it will be observed that all stoppages for incidental repairs, attention to the mechanism, fittings, source of heat supply, for the purpose of allowing unruly horses to pass, or for other reasons analogous to those which might be encountered in a regular service, are included as part of the time required for the completion of the journey.

Summary of Factors affecting the Costs per Net Ton-mile.

Vehicle.	Prime cost.	Speed, miles per hour.		Load carried.	Ton-miles of load per annum of 260 working days.	Time occupied in obtaining the declared working pressure.	Fuel consumption.			Water consumption.		Motive power per ton-mile of load.	Attendants per ton-mile of load.
		Actual running	Commercial				To raise steam.	Per vehicle-mile.	Per ton-mile of load.	Per vehicle-mile.	Per ton-mile of load.		
	£			Tons.		Minutes.				Galls.	Galls.	d.	d.
Lifu (No. I.)	524	8·29	7·02	2·20	40,040	20	1·0 galls.	0·655 gall.	0·298 gall.	4·54	2·06	1·22	0·55
Thornycroft (No. III.) ..	750	3·41	2·79	4·72	34,434	21	65 lb.	19·07 lb.	4·03 lb.	9·11	1·93	0·36	0·91
Thornycroft (No. IV.) ..	630	5·98	5·22	2·53	24,206	21	64 lb.	9·20 lb.	3·64 lb.	3·69	1·46	0·32	0·91
Leyland (No. V.)	375	5·25	4·45	4·06	46,446	22	0·75 galls.	0·528 gall.	0·130 gall.	3·41	0·84	0·18	0·47

The cost of liquid fuel—kerosene—was 4d. per gallon, and of coal, 15s. 6d. per ton.

The annual expenditure on each of the systems above worked out, according to the first table, and including interest on prime cost at 5 per cent., depreciation at 15 per cent., cost of fuel, water, repairs, insurance, and men's wages, comes out as follows:—

	Lifu (No. I.).	Thornycroft (No. III.).	Thornycroft (No. IV.).	Leyland (No. V.).
35 miles per day laden	5·19d. per net ton mile at 7·02 miles per hour.	3·09d. per net ton-mile at 2·79 miles per hour.	4·66d. per net ton-mile at 5·22 miles per hour.	2·39d. per net ton-mile at 4·45 miles per hour.
70 miles per day laden	3·53d. per net ton-mile at 7·02 miles per hour.	3·64d. per net ton-mile at 2·79 miles per hour.	3·48d. per net ton-mile at 5·22 miles per hour.	2·10d. per net ton-mile at 4·45 miles per hour.
35 miles laden and 35 miles light per day	6·66d. per net ton-mile at 7·02 miles per hour.	7·16d. per net ton-mile, speed as above.	6·84d. per net ton-mile, speed as above.	3·94d. per net ton-mile, speed as above.

The following are the conclusions arrived at by the judges:

Excluding the six-wheeled vehicle No. III., which we regard as not being adapted to the traffic intended, we are of opinion that the vehicles presented for trial were suitable for a number of trade purposes, and capable of taking the place of horse haulage in Liverpool and neighbourhood with economy.

The vehicles were capable of economically competing for the transport of loads up to four tons, over such distances as were embraced by the trials—thirty or forty miles—where the rates are equal to those in operation in the Liverpool district.

The volume of traffic between the port of Liverpool and the manufacturing districts is too large and varied to be dealt with by any isolated scheme of motor wagon transport; there are, however, undoubted opportunities for the establishment of carrying undertakings, and for the adoption of self-propelled vehicles, by individual firms on a more limited scale with a prospect of gradual and remunerative extension.

Although the calculated costs per net ton mile show a saving on existing railway rates, we do not consider that motor vehicles could successfully compete for traffic in opposition to reduced railway rates, except under special circumstances.

Whilst it has been practically demonstrated under test of actual working of great severity, that new machines may work in commercial competition with railway rates with loads up to four tons, and over distances of from thirty to forty miles, the severity of the duties which auto-motor vehicles have to perform in carrying heavy loads at useful speeds on common roads is so great as to involve even greater maintenance and, or, depreciation charges than those which we have used in our calculations. This has a two-fold effect. First, in increasing the cost of working, and, second, in rendering the service in a measure uncertain. We cannot disguise the fact that motor vehicles, in the present stage of their development, are liable to temporary breakdowns which might cause considerable delay and annoyance.

The imperfections of common roads are the principal causes of the heavy maintenance and depreciation charges, and of the element of uncertainty which at present attaches to any service of motor vehicles. On good macadam roads, with moderate gradients, the vehicles to which prizes were awarded would do good service with the respective loads carried during the trials, but none of them could be relied upon for a regular service on roads such as those of the routes selected for the competition. We anticipate that the consumption of fuel and water may be very considerably increased when the vehicles have to run over wet, muddy, or exceptionally heavy roads; but as these conditions will be accidental, they will probably not very materially alter the average costs per net ton mile.

The form of wheels and tires adopted by all the manufacturers, though probably perfectly efficient as carriers, were all structurally more or less inefficient as drivers.

None of the vehicles were able to manœuvre into and out of an embayment as effectively and rapidly as may be expected when time and experience have effected improvements in design, but they were capable of going anywhere that horse-drawn vehicles are ordinarily required to go.

The general control, stopping, starting and steering of the vehicles, when working on the road and amongst traffic, was at least as good as with the best types of horse-drawn vehicles.

The hill-climbing powers of the vehicles were much superior to to those of horse-drawn vehicles, when commercial efficiency is considered. At least two speed gears, or an equivalent reserve of power, are essential to successful working on common roads with steep or even with average gradients.

Generally, two much attention was required by the various operations of regulating and driving the vehicles, and in order that self-propelled vehicles may command a wider adoption than can yet be confidently recommended, there must be an extended use of automatic arrangements analogous to those in other fields of mechanical science. When such improvements are made they will have a great effect in placing motor vehicles upon a more practical basis for traffic in cities, by enabling comparatively unskilled attendants to undertake their management.

American Locomotives for Finland.—Among locomotives recently built for export are seventeen two-cylinder compound engines for Finland, a country which has used American locomotives for many years. The engines are of the Mogul type, having six coupled driving wheels and a two-wheel pony truck or bogie. The cylinders are outside, 15½in. by 20 1/16in. and 25in. by 20 1/16in. The compounding is on the Richmond system. The driving wheels are 49½in. diameter, and truck wheels 31in., the driving wheel base being 12ft. and the total wheel base 18ft. 8½in. The boiler is 45in. diameter in the barrel, and has 150 brass tubes, with copper ferrules in the fire-box ends. The fire-box is of copper, 47in. by 39in. A large cab is used, built of steel, and partially shut in at the back. The engine weighs 68,000 lb., of which 53,000 lb. are on the driving wheels. The grate area and heating surface are limited. The fire-box has 70 square feet, and the tubes 674 square feet of heating surface, or 744 square feet in all, while the grate area is 12½ square feet. Most of the engines are fitted for burning wood, and have "balloon" stacks or funnels, with spark-arresting devices. The others will use coal for fuel. The engine has spring buffers, an iron pilot or "cowcatcher," and three headlights, which burn Pintsch gas. The Westinghouse air brake is used. On top of the cab is a German bell device, the bell being rung by steam. The blast nozzle is set very low in the smoke-box, and above it is a petticoat pipe, whose top is within a few inches of the base of the funnel. The height from the rail is 6ft. 3in. to the centre line of the boiler, and 13ft. 5in. to the top of the funnel. Six-wheel tenders with plate frames are used, the wheels being 37in. diameter.

Japanese Railways.—The railways on the West Coast constructed up to the present time are the Hokuritsu Government line, the Nanao Railway, the Chiuritsu Railway. The Hokuritsu Railway begins at Mailbara, where it forms a junction with the Tokaido Railway, and runs in a north-easterly direction through Tsuruga, Fukui, and Kanazawa, it is ultimately to be extended along the coast to Naoetsu, but as yet only the preliminary surveys have been made. In July, 1896, it was completed as far as Fukui, a distance of 38 miles 41 chains from Tsuruga, in September, 1897, as far as Komatsu, a further distance of 21 miles 58 chains; and in July, 1898, it was opened as far as Kanazawa, a distance of 25 miles 44 chains, thus making a total distance completed and open for traffic of 85 miles 63 chains from Tsuruga. Beyond Kanazawa it has been finished as far as Tsubata, 10 miles, but it is not yet open for traffic. From Tsubata to Takaoka, 13 miles, it is at present under construction, and it is expected that it will be finished by November, 1898. The last section to Toyama, 11 miles, will probably be finished by March, 1899. Its total length from Mailbara to Toyama will then be 151 miles 63 chains. Of the stations Tsuruga, Imajo, and Kanazawa are the most important, locomotive depôts being situated at these places. The Nanao Railway is owned by the Nanao Railway Company, with a capital of £105,000, and was opened for traffic in April, 1898. It starts at Tsubata, where it forms a junction with the Government line to Toyama, and runs northward to Nanao, in Noto, a distance of 32 miles 40 chains. The stations are situated at Tsubata, Unoke, Takamatsu, Hodacho, Shikinami, Hakui, Chiji, Kanemaru, Notobe, Tokuda, and Nanao. It is still in an incomplete state, the bridges being merely temporary wooden ones, and the station at Tsubata being not yet finished. In order to facilitate transport from the railway to vessels in Nanao harbour, a jetty has been constructed at Yadashin, to the north-east of Nanao, a further distance of 60 chains. The Churitsu line runs from Takaoka in the western part of Toyama Prefecture, southwards to Johana, passing through Toide, Domachi, Fukumo, and Fukumitsu. It was opened to traffic in January, 1898, the total length being 18 miles 50 chains. It is also proposed to extend the railway northwards from Takaoka to its port Fushigi, a distance of 4 miles, but as yet the necessary land has not been purchased.

RAILWAY MATTERS.

THE Colne Corporation are taking steps to obtain an order under the Light Railway Act, 1896, to construct a light railway within the borough, commencing at the terminus of the boundary of the borough of Nelson.

THE Santa Fé Railway Company is said to have made arrangements to light all its limited trains between Chicago and Los Angeles, a distance of 2200 miles, with electricity generated from the car axles. Each train will have about 5000 candle-power.

THE directors of the London, Brighton, and South Coast Railway Company have appointed Mr. T. N. Wylie, of the London, Chatham, and Dover Railway Company, continental traffic manager, in the place of Mr. Victor Gerard, who has resigned.

AN attempt was made on Sunday night, near Bickleigh Station, to wreck a Great Western passenger train running on a branch line from Launceston to Plymouth. Large stones were placed on the metals, but, although some damage was done to the engine, it fortunately did not leave the rails.

WORK on the Fishguard and Rosslare Railway continues, and doubtless will be attended with additional vigour with the new year. The projects include substantial changes at Goodwick, the harbour of which is capable of great development and improvement. The primitive arrangement at this place is to unload coal and limestone as near the shore as possible in the sea, and when the tide recedes the cargoes are cleared by carts. All this and other peculiar methods are now to disappear.

A COLLISION recently took place on the Grand Trunk Railway of Canada. It appears that a goods train was waiting in a siding, four miles west of Trenton, for the passenger train, which had left Montreal at eight o'clock on the previous evening and was due at Toronto at 6.59 a.m., to pass. For some unexplained reason the engine of the passenger train took the wrong points, though the switch and signals are said to have been all right for the main line. The results were disastrous. The two locomotives, though they did not leave the metals, were locked together. The baggage van was crushed into the carriage behind it, in which were a number of passengers. Altogether twelve passengers are reported killed, and fourteen injured, while the driver and stoker of the passenger train were also killed.

DURING the last official year considerable additions were made to the mileage available for traffic on the railways in the Bombay Presidency. The most important of these was the Ahmedabad-Parantij Railway, of which line 54 miles were opened. There was also the Jamnagar line, 50 miles; the first section of the Rajpipla State Railway, 19 miles; and the extension of the Gaekwar's Dabhoi Railway, from Vishwamitri to Padra, 7 miles. The useful little line from Wadhwan to Dhrangadhra, 20 miles long, has been opened since the close of the official year. The Bombay Government has now under its control 6260 miles of railway. Of this mileage, 2141 miles are on the standard gauge; 3905 miles on the metre gauge; and 213 miles on the 2ft. 6in. gauge. A length of 227 miles on the standard gauge and 17 miles on the 2ft. 6in. gauge remained unfinished at the close of the year.

IT is worth while to put on record, before it is forgotten, the origin of the name of "Calvert," which has been given to a little wayside station, the first on the Great Central Railway's London extension after one leaves Quainton-road. There is no village named Calvert, which is therefore a purely arbitrary name for this station, which serves a circle of some half-dozen villages, situated some distance away. The name is explained by the fact that the late Sir Harry Verney, the largest landowner in this part of Buckinghamshire, sold some thirty acres to the Manchester, Sheffield, and Lincolnshire Railway—as the Great Central then was—and withdrew all opposition to the Railway Bill on condition that the station to be built here should be named "Calvert," that having been Sir Harry Verney's family name before he changed it on coming into the Calvert estates. The origin of the name of "Verney Junction," on the London and North-Western Railway, not many miles distant, at a place where there is no village of that name, is to be explained in the same way.

A COLLISION occurred on Thursday evening, the 24th ult., on the London and South-Western Railway, near Clapham Junction, about three-quarters of a mile up the line beyond Queen's-road Station. The 5.32 train from Waterloo to Richmond, *vid* Kensington, on the new West London branch line, arrived at Queen's-road at 5.40, and was travelling towards the next station, when, at the crossing opposite the West London signal box, where the line branches off for the West London stations, a light engine ran into the train, striking it in the middle portion. The carriage which was struck by the engine immediately toppled over on to its side, and in its fall dragged the three adjoining carriages off the rails. Fortunately, little personal injury was sustained, but many passengers, especially those who had been in the middle portion of the train, complained of feeling the effects of the shock. In consequence of the accident all four Windsor lines were completely blocked, and it was only after some three hours of hard work that anything like order in the service was obtained. The derailed carriages have sustained but little injury, and there was only comparatively slight damage to the permanent way.

THE limitations to the overhead trolley are now quite generally recognised. It has been found that it is difficult efficiently to transmit by means of the ordinary form of trolley wheel more than 150 ampères from the wire to the wheel without excessive sparking and loss. The speed at which a trolley wheel will stay on the wire, through section insulators, special work, and switches, is limited in good practice to not much over ten miles an hour, says Mr. Pepper in the *Journal* of the Franklin Institute. When the trolley stand and wheel are both designed for high speed and the line carefully constructed, it is possible to run on straight-line work at a speed of about thirty miles an hour. Beyond this speed the tendency to throw the wheel from the wire, owing to slight obstructions on the trolley wire, is very great. If the wheel leaves the wire at this speed it is almost certain to either break the trolley pole or bring down a large portion of the overhead construction. It is for this reason that experiments have been and are being tried to substitute a fixed conductor near the ground with a large surface contact for the overhead trolley wire for high speed and heavy currents.

UNDER the auspices of the Great Northern Railway Company a new company has been formed for the construction of a deep-level electric line from Wood Green to the Strand. The railway is to be in four sections. The first two—from Wood Green to Finsbury Park and from Finsbury Park to King's-cross—will run practically the whole way under property of the Great Northern Railway Company. From King's-cross, the line will pass under the Metropolitan Railway, and so *vid* Judd-street, Russell-square, and Southampton-street to Holborn, this being the third section. The fourth section extends from Holborn to the Strand, running beneath the projected new street of the London County Council, and the terminus is to be at the end of this new thoroughfare, in the vicinity of Somerset House. The stations for the underground route—so far as concerns that portion of it under the existing Great Northern line—will follow the sites of the present stations of that company. There is to be an exchange station at Finsbury Park, underneath the existing station, and a station at King's-cross beneath the present terminus. It is probable that another station will be constructed at Russell-square, and in all likelihood arrangements will be made for the interchange of traffic at Holborn with the Central London Railway. The project will be brought before Parliament in the coming session.

NOTES AND MEMORANDA.

DURING the present year seventy-four vessels, aggregating 238,281 tons, have been launched on the Wear. This total already exceeds that for any previous whole year.

THE total production of flax in Ireland during 1897 was 6818 tons. It required 45,576 acres of land to produce this crop, and the yield per acre was 23·93 stones. In 1896 the total produce was 10,844 tons.

SOME figures were recently published in the *Street Railroad Journal*, relating to the test of a Patton motor tramcar which was run on the Great Western Railway of the United States, a distance of 274·1 miles. The net running time was 16 hours 45¼ minutes. Taking the cost of gasoline at 2½d. per gallon to cost of fuel amounted to 0·53d. per car mile, or 0·032d. per ton mile.

ABOUT 50 per cent of the world's production of diamonds goes to Belgium for cutting, the remainder of this work being done chiefly at Amsterdam. The Belgian and Dutch cutters buy the rough stones in London, whither they are shipped from South Africa. The value of the rough diamonds purchased by the Belgian cutters in 1894-96 is given by the *New York Engineering and Mining Journal* as follows:—1894, £1,550,000; 1895, £1,930,000; 1896, £2,123,000.

THE manufacturing of willow ware from the rods is an industry which, though as yet in its infancy in America, has been slowly growing during the last few years. In 1890 there were in the United States, according to the census, 403 willow ware establishments, with a capital of £540,000, employing 3732 persons, paying annually the sum of £253,800 for wages, and producing £726,720 worth of manufactured ware. The value of raw material consumed was £279,700—an increase of 61 per cent. over that of 1880.

THE total number of vessels passing through the Suez Canal in the month of July last was 337, of a gross tonnage of 1,244,040 tons. Of these 337 vessels, 205 were British, with a gross tonnage of 761,259 tons; 35 German, 129,302 tons; 25 Spanish, 124,175 tons; 20 French, 78,381 tons; 15 Dutch, 41,338 tons; 4 Japanese, 23,472 tons; 4 Russian, 19,624 tons; 9 Ottoman, 15,838 tons; 5 Austro-Hungarian, 15,739 tons; 4 Italian, 14,034 tons; 4 Norwegian, 7347 tons; 4 Egyptian, 6543 tons; 1 Danish, 4420 tons; 1 Chinese, 1605 tons; 1 Greek, 971 tons.

COMPARATIVE statistics dealing with the three methods of tramway traction in New York, viz., electric, cable, and horse traction, have been published in the *Street Railroad Journal*, from which we gather that the total operating expenses per car mile were 8·21d. for cable haulage and 8·93d. for horse cars, but only 5·12d. for the electric conduit system. These figures include power costs, transportation or traffic expenses, maintenance, and general management; but capital charges are omitted, though if included would probably still further improve the showing in favour of electric traction. A still better result is shown by the three months' working ended September 30th last, the figures being 8·78d., 8·99d., and 5·03d. respectively.

A BLUE-BOOK just published on the metallurgical industries of Liége shows that there are fourteen blast furnaces, all of which were at work during 1897. The material consumed included 131,742 tons of Belgian ore, 732,728 tons of foreign ore, 68,022 tons slag and scrap, and 176,698 tons of limestone flux; while of combustibles there was used 467,515 tons of coke and 3319 tons of coal. The production comprised 67,342 tons of forge pig iron, 12,636 tons of manganese pig iron, 183,701 tons of pig iron for Bessemer steel, and 140,838 tons of pig for the Thomas steel process, a total of 404,517 tons. The output is by far the largest on record.

A NOVEL method of moving a tank is described in a recent issue of the *Génie Civil*. The tank was used to hold petroleum, was 82ft. in diameter, 32·8ft. high, and weighed 140 tons. To remove it 131ft. a wall 2ft. high and 1ft. thick was built on the level surface of the porous sandy soil, so as to enclose the old and new masonry foundations, which stood a few inches above the surface of the ground. The tank was built with a flat bottom and curved top, from plates 0·16in. to 0·47in. thick. It was first filled with air at a pressure of 8in. of water. Then water was pumped into the artificial pond enclosed between the temporary walls until it floated the tank from its foundations, the tank then drawing 8·2in. More water was pumped in to raise the tank 4½in., and it was then hauled by a windlass and rope to its new site. It was held against a semicircular row of piles driven around the new foundation until it sank in its permanent position as the water was slowly drawn out of the pond. The tank was uninjured and its removal occupied a few minutes only.

A GERMAN contemporary, the *Chemische Revue*, recently contained an article by Dr. M. Albrecht on the relative qualities of American and Russian petroleum. From the examinations made, Dr. Albrecht draws the following conclusions:—(1) The flash point of the Russian oil is from 5 to 7 deg. Cent. higher than that of the American oil. The former, therefore, is safer, as far as danger from fire or explosion is concerned. (2) The Russian petroleum contains much more pure illuminating oil—passing between 150 deg. and 300 deg. Cent.—and far less heavy oil than American "Standard White." (3) The Russian petroleum is perfectly free from paraffin, hence, remains, like the residue from its distillation, fluid at even 20 deg. Cent., while American "Standard White" becomes dimmed and thick at from 9 to 12 deg. by the paraffin solidifying, and solid at 17·4 deg. It also contains from 20 to 26 per cent. of heavy paraffinous oil, which at 6 to 8 deg. Cent. is still solid. (4) The illuminating power of the Russian oil is not inferior to that of the average American "Standard White." The lighter grade of the Russian "White Star" develops a materially higher illuminating power than most of the American oil samples examined. (5) The oil consumption for the same illuminating effect is 14 per cent. less with Russian oil than with American. (6) Notwithstanding the greater height of the flame—0·28in. from the Russian oil, as against 0·12 to 0·26in. from the American—from two to three times as much wick is consumed by the American oil as by the Russian.

THE erection methods of the Francis Joseph Bridge at Budapest were somewhat peculiar, says the *Engineering Record*. The bridge is a highway structure about 1088ft. long. The steel superstructure, weighing 6000 tons, is carried on pneumatic caisson foundations, and the total cost was 900,000 dols. There is a centre span of 514ft., inclusive of the two 206ft. channel cantilevers, which are balanced by the two 257ft. anchor arms. First, false work was placed under the anchor arms and the first three panels of the channel cantilevers. Then each truss was erected from the anchorage to within three panels of the tower by small gallows frame travellers. Two-storey top false work was built on the trestles above the bridge floor, reaching two-thirds of the distance to the top of the centre panels, and on it another gallows frame strident traveller completed the erection of the cantilevers to three panels beyond the towers. A wooden false work tower was built up around each permanent tower 118ft. high, in order to erect it. The remainder of each channel cantilever arm was erected without false work by a tower traveller, which did not overhang, but ran on the bridge floor between the trusses, and had an upper cross beam overhanging the top chords transversely. This traveller was apparently supplemented by a platform about 40ft. by 60ft. at the level of the bottom chord, which was carried on false work built up from the decks of river boats successively moored below the last panels under construction. After the cantilever arms had been completed, the false work at the towers was removed, and pile false work was erected to assemble the suspended centre span upon.

MISCELLANEA.

THE new American battleship Wisconsin was launched at San Francisco on Saturday last.

IT is stated that Mr. William Fife, of Fairlie, the designer of the American challenger yacht Shamrock, has invited an Essen firm to supply nickel steel plates of light weight for the Shamrock's construction.

TWO thousand tons of rails have just been exported from Baltimore, U.S.A., to Bombay, and a shipment of 500 tons from the same port is about to be made to Ireland. These are said to be the first shipments to either of the above-mentioned destinations.

A CABLE from Pekin announces that a contract has been signed by Mr. Pritchard Morgan on the one hand, and the Sub-Commissioner of Mines in Sze-Chuan on the other, granting the former permission to work mines not already opened for all minerals in that province, the Government to receive a royalty of 5 per cent. on coal, iron, and petroleum. Sze-Chuan is said to be the richest mineral-bearing and industrial province in China.

IT is announced that the Chinese Minister has joined the Article Club, "in order that he may have an opportunity of practically demonstrating his goodwill towards this country and his desire to assist its manufacturers in the none-too-easy task of securing fresh and retaining old markets in the Celestial Empire." As the Article Club is composed of manufacturing firms, his Excellency considers that by joining the club he will be best able to assist the introduction of English manufactures into China. Some important proposals emanating from his Excellency are now before the club, which have for their object the securing of permanent exhibitions of British manufactures in China under the auspices of the Chinese Imperial Government.

THE London Chamber of Commerce received yesterday particulars of a law passed in August last which will come into operation on January 1st next, which is of particular interest to those having trade relations with the colony of Natal. Under this law commercial travellers travelling in the colony on behalf of any house, company, or individual, not possessing a commercial establishment in the colony already taxed, will in future have to take out a licence. The licences will be issued for the calendar year whenever taken out, *i.e.*, will expire on December 31st, the tax thereon being fixed at £10, reduced to £6 for licences taken out after July 1st. The fine for infringement is £40, with liability in case of non-payment to imprisonment, with or without hard-labour, for a term not exceeding three months. An extension of weight for the luggage of commercial travellers to be carried free on the railways is provided for. The full text of the document, which has reached the London Chamber, can be inspected at the offices of that body.

IN a leading article on the Soudan rewards in the current issue of the *Naval and Military Record*, our contemporary says:—"The crowning absurdity of the naval honour list is the detention of Engineer Edmund Bond, D.S.O., in his present rank for the period of two years. We regard this action of the Admiralty as a great injustice to an officer who was most warmly and conspicuously praised in Lord Kitchener's despatches. Mr. Bond was given more praise for his services than any executive naval officer engaged in the operations; yet the executives are promoted at once, and Mr. Bond is doomed to lose half the fruit of his conduct through a silly reluctance on the part of the Board to make him a chief engineer at his present age. This deserving officer was an assistant engineer ten years ago, and has held rank as engineer six years. It is impossible to believe that an executive officer of twenty-eight is more fitted to become commander of a ship than Mr. Bond is fitted to become a chief engineer at the age of thirty-one! The prejudice," says our contemporary, "is inconsistent, and exemplifies the whole action of the Admiralty Board towards officers of the engineering branch of the Navy."

ACCORDING to the Press Association, there is to be established next month a new service of steamers between this country and Canada, with a saving in time of about two days, and in distance of 150 miles, as compared with the Liverpool route. The point of departure on this side is Milford Haven. The line has been formed in Canada by persons interested in the Atlantic and Lake Superior Railway of that country, the steamers being the property of the Canadian Steamship Company. The Great Western Railway Company will co-operate by issuing through rates for goods and parcels and perishable articles between Canada and places on their line. The vessels, which are intended for passengers as well as goods, will ply fortnightly between Milford Haven and Paspebiac—an ice-free port at the mouth of the St. Lawrence—whence the railway will carry the goods and passengers away to Montreal and other places. The first vessel, the Gospesia, is to leave Milford Maven on December 7th, and is to be followed by the Paspebiac. In the spring the steamers are to go weekly. Their speed is about 14 or 15 knots; but they will, it is expected, be replaced ultimately by faster vessels doing 18 or 20 knots.

ARTILLERY officers who used the howitzers at Omdurman have sent in their reports on the Lyddite shell. As an explosive it does not seem to answer so well as was expected in destroying buildings. According to the *Naval and Military Record*, it failed to demolish the Mahdi's tomb, though several Lyddites went through the cupola and exploded inside. The building had eventually to be destroyed by gun-cotton. An astonishing number of shells had also to be used to batter down a mud hut in the line of fire. But in the destruction of life the Lyddite shell is terrible. It kills all around it. Horses and men within a large area simply drop down as though the angel of death had passed over the field when the shells burst. Report says 30 per cent. of the enemy found dead through artillery fire showed no signs of wounds. They had been killed by the air concussion of the explosive. The shell was not expected to be so deadly in its effect, though better results were anticipated in demolishing buildings and fortifications. In mountain warfare the Lyddite shell would be invaluable. There would not have been such a sacrifice of life on the British side at Dargai had the howitzers been used in the North-West Frontier war.

THE Clydebank Engineering and Shipbuilding Company has contracted with the American Line for the construction of two new passenger and cargo steamers, each of about 10,000 tons, intended to augment the fleet of Red Star liners—Société Anonyme Belge-Americaine—plying between Antwerp and Philadelphia, to all intents and purposes a part of the New York and Southampton American Line. The vessels are to be propelled by twin screws, and to be 560ft. in length. Though in size the new vessels will resemble, they are not intended to rival, in speed or accommodation, the larger and more powerful vessels of the other Atlantic lines, albeit they will, in design and equipment, be thoroughly up to date, and worthy the reputation of the builders. It was at first reported that four vessels had been placed with the Clydebank firm, and two with Messrs. Hawthorn, Leslie, and Co., on the Tyne—six steamers in all, representing a tonnage of 56,000—but this has been contradicted. The order as amended is considerable enough, no doubt, and the fact of its having been virtually placed by the American Line has suggested to those interested in the contract in America the propriety and utility of using American-made material in the vessels' construction, especially should there prove to be any difficulty, either as to cost or prompt supply, in obtaining material made in this country. The home steel market is at present so conditioned as to make the builders regard with complacency, if not favour, the employment of American steel.

EXTENSIONS AT BARRY DOCK, 1898

(*For description see page 536*

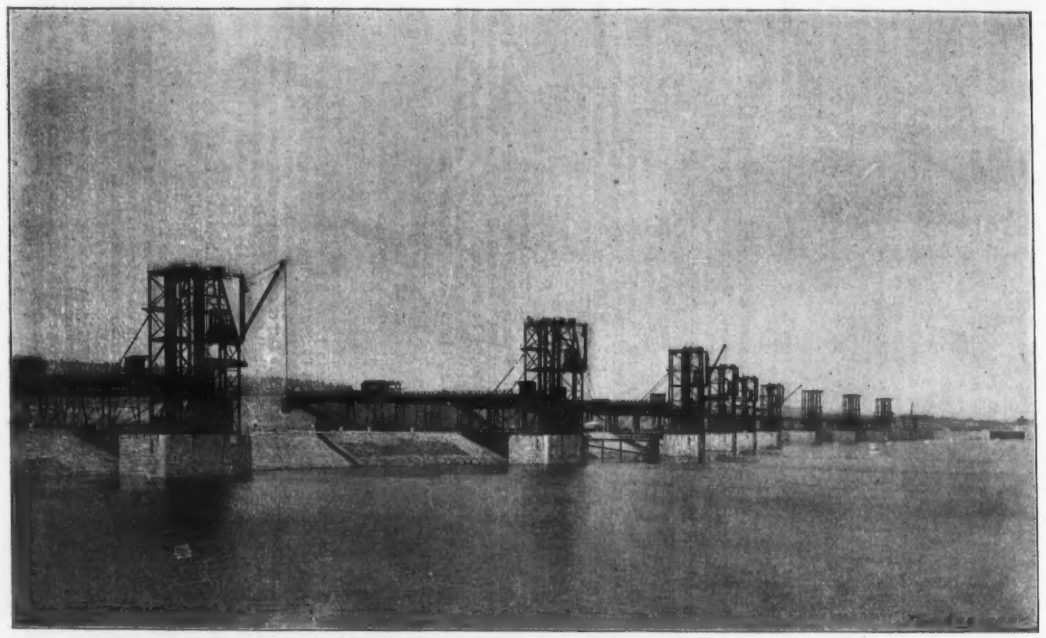


Fig. 2—NORTH QUAY COAL TIPS, DOCK No. 2

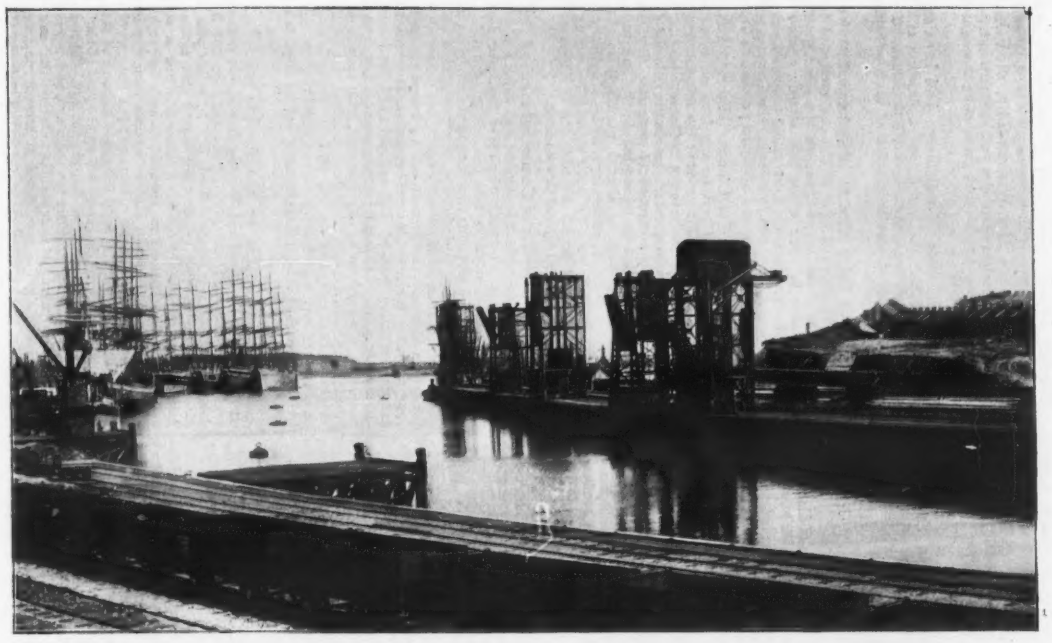


Fig. 3—DOCK No. 1 AND COAL TIPS

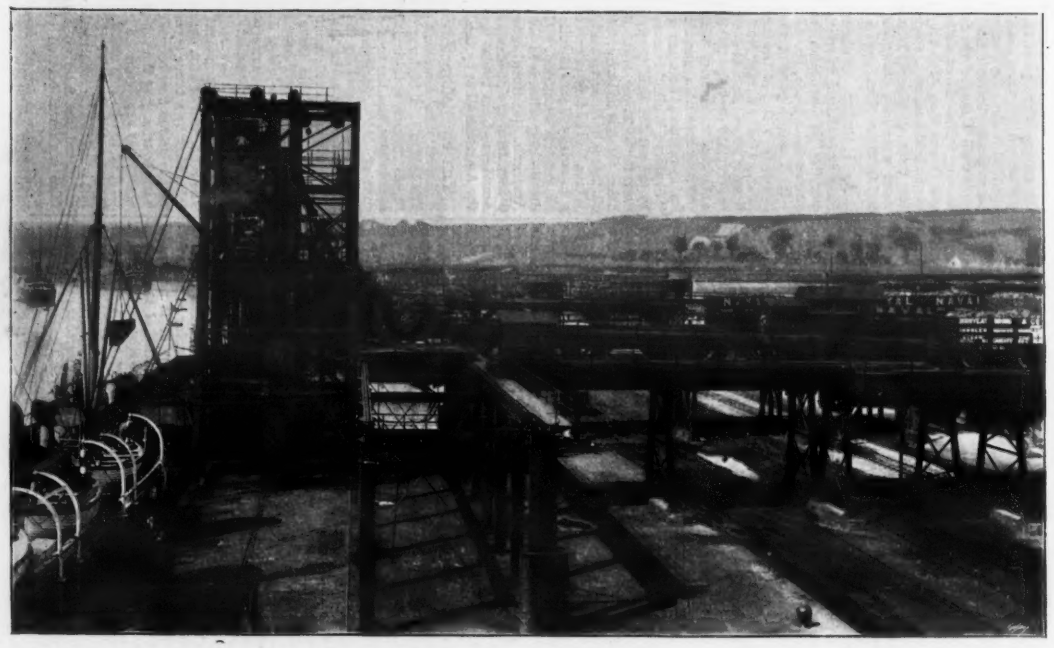


Fig. 4—COAL TIP AND TRAVERSER

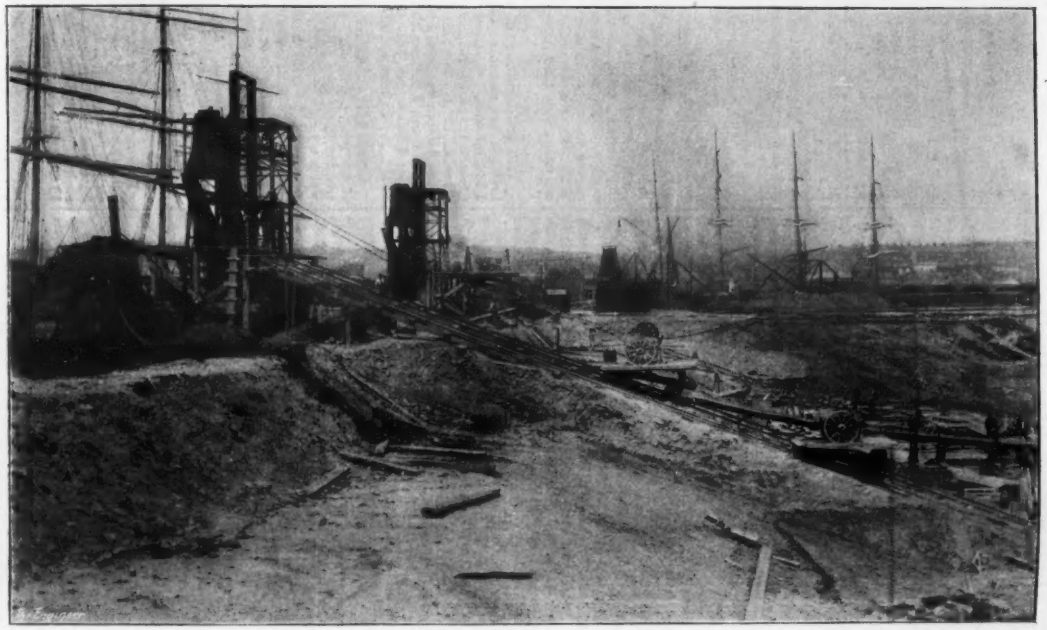


Fig. 5—EXCAVATING THE JUNCTION CUT

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Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

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PUBLISHER'S NOTICE.

*** *If any subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. G. F. (Essex)—We hope in a short time to publish a full description of the very plant to which you refer.

C. L. S. (Southsea).—You will find a description of Unwin's autographic apparatus, and examples of diagrams taken with it from a number of metals, including cast iron, on pages 384-5 of Lineham's "Text-book of Mechanical Engineering."

D. J. L. (Sudbury).—Several books on motor cars have appeared, but we cannot recommend any of them. The most recent is "Petroleum Motor Cars," by Louis Lockert (Sampson, Low, and Co.). Most of the types of cars which were exhibited at the shows have already been mentioned or described in THE ENGINEER.

MEETINGS NEXT WEEK.

ROYAL INSTITUTION OF GREAT BRITAIN.—Monday, December 5th, at 5 p.m., General Monthly Meeting.

SOCIETY OF ENGINEERS.—Monday, December 5th, at 7.30 p.m., at the Royal United Service Institution, Whitehall. Paper, "Bacterial Treatment of Sewage," by Mr. George Thudichum, F.C.S.

THE INSTITUTION OF JUNIOR ENGINEERS.—Friday, December 9th, at 8 p.m., at the Westminster Palace Hotel, Victoria-street. Paper, "British Cable Tramways and their Construction," by Mr. E. A. Heath, Member.

THE BRITISH ASSOCIATION OF WATERWORKS ENGINEERS.—Saturday, December 10th, at 11 a.m. Paper, "Water Supply from the Lower Greensand and Constructional Works connected therewith at Leighton Buzzard," by Mr. H. Bertram Nichols, Assoc. M. Inst. C.E.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 6th, at 8 p.m. Paper to be discussed, "The Effect of Subsidence due to Coal-workings upon Bridges and other Structures," by Mr. Stanley Robert Kay, Assoc. M. Inst C.E Paper to be read, "The Ventilation of Tunnels and Buildings," by Mr. Francis Fox, M. Inst. C.E.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 8th, at 8 p.m., at the Institution of Civil Engineers. 25, Great George-street, Westminster, S.W. Papers, "Improvements in Magnetic Space Telegraphy," by Prof. Oliver Lodge, D.Sc., F.R.S., Member; "Telegraphy by Magnetic Induction," by Sydney Evershed, Associate.

SOCIETY OF ARTS.—Monday, December 5th, at 8 p.m. Cantor Lectures. Four Lectures on "Acetylene," by Prof. Vivian B. Lewes. Lecture III.: The commercial generation of acetylene—The types of generator in use—The actions taking place in acetylene generators, and the effect upon the gas produced—The purification of acetylene for domestic consumption.—Tuesday, December 6th, at 4.30 p.m. Foreign and Colonial Section. Paper, "The Yangtse Basin and the British Empire," by Mr. Archibald Little, F.R.G.S.; of Chungking.—Wednesday, December 7th, at 8 p.m. Ordinary Meeting. Paper, "Egypt and the Soudan, in 1897 and 1898," by Mr. W. T. Maud, artist and correspondent to the *Graphic*.

THE ENGINEER.

DECEMBER 2, 1898.

ENGLISH AND AMERICAN MACHINE TOOLS.

THE number of exhibitors of machine tools at the Stanley Show this year was less than on the last two or three occasions. This was probably due in a large measure to the sudden drop in prosperity of the cycle trade, and in a lesser measure to the fact that the makers of cycles are already supplied with as many tools as they require under the altered circumstances of their business. It was on this account also not surprising to find that the few exhibitors who had displays of importance showed tools which would appeal more to the general engineer than to the makers of bicycles, tricycles, and motor cars. Instead of having the tools in motion at work on hubs, bolts, screws, and other parts for cycles, it was noticeable that a large number of them was turning out the requisites of general engineering establishments; brass cocks instead of hubs; bevel wheels in place of sprocket wheels; rivets or large screws in place of gibs and small screws, and so on. In fact, the general aspect indicated that the exhibitors were exposing their wares not to attract the old customers, but to draw new purchasers in quite a different line of business; and except for a few tools it might almost be said that the exhibits were out of place at a cycle show. We were informed by one exhibitor that, with few exceptions, the persons who had visited his stand had no connection with the cycle trade, but were engine-makers, electricians, locomotive superintendents, machine tool-makers, and managers of general engineering works. All this seems to us unquestionably to point to the fact that the English manufacturer is at length beginning to recognise that the restriction in the way of their use being now removed, automatic machine tools are of great importance. If he has at last put away from him the opinion that they are all "jim-crack" contrivances, has discovered that they are worthy to take a prominent place in his shops, and that they are capable of doing all, or nearly all that is claimed, then he owes a debt of gratitude to the bicycle craze, to the bicycle show, and to the bicycle makers. There can be absolutely no question that the automatic tool and the various automatic devices applied to machine tools of the ordinary kind have come as a permanency. The days of experiments have in a large measure passed, and although there may be still in this country automatic tools which need more attention than those of older type, yet, on the whole we feel sure it will be found that the automatic tool—we use the word in a wide sense—has arrived at such a state of perfection that no longer need any hesitation be felt in adopting it. This opinion is confirmed on all sides. Manufacturing engineers of all sorts are, since the conclusion of the strike, and in consequence of their improved position with regard to their employés which that strike brought about, removing or not purchasing machines of the older type, but are adopting the new patterns. We feel that exception will be taken to this statement on the ground that English tool makers are as busy as possible, so busy, in fact, that they are unable to accept orders for less than months ahead. We believe this may be accounted for by the fact that the tools they manufacture are still largely required for the old purposes, whilst the automatic tool breaks new ground. In very many respects, and for very many purposes, the older tool will continue to hold its own. The use of the automatic machine appears only when numbers of similar parts have to be made; for general purposes, and for the work of the average small engineer's shop, it is not well adapted, and cannot be used economically; it is therefore only when specialisation begins that the door is thrown open to it. It is also beyond contention that no finer tools of large size are made in any part of the world than many of our well-known English makers can turn out, and these makers have a reputation which brings to them sufficient orders to keep their shops extremely busy, in spite of the advances of the smaller class of tools.

It is, however, we think, to be regretted that the English maker will not turn his attention to the design and manufacture of the class of machines which we are considering. It was a fact which could have failed to strike but few observers that there were practically no tools of English manufacture exhibited at the Stanley Show, and at the National Show a firm which has always followed closely on American models had the best exhibit. Is it possible that English manufacturers cannot find time to devote some attention to this class of machinery, and so offer battle to the increasing competition, or is it that they still profess to despise American methods? If the latter is the cause, they would do well to undeceive themselves by an inspection of American machines. We have frequently heard it stated that the imported article was weak and roughly made. A few years ago that was to a great extent true, but it is so no longer. American engineers do not stand still, and they have eagerly learnt by experience. The consequence is that their tools are now-a-days at least as stoutly built as our own and are as well finished, whilst in accessibility of their working parts, in ingenious automatic devices, in adaptation for rapid work, in convenience and handiness, they are far ahead of the productions of most British firms.

We say this with no intention of "puffing" American productions. It is said with the hope of succeeding in removing some of the bias which misguides the British manufacturers. We have been bound on more than one occasion to draw unfavourable comparison between English and American tools mainly on the points we have mentioned. It has been to us, we feel sure our readers will believe, no pleasure to do so, but it is necessary that the fact should be insisted on, that the American competition in this direction is of a serious nature. Much of the success of the makers on the other side of the water is due to the fact that they do not wait for their customers to tell them what is wanted, but show how much more can be done than was deemed possible, that is to say, because they lead and do not follow manufacture. This seems to us an important point. Probably many engineers who go for the first time to such shows as those held last week at the Agricultural Hall and Crystal Palace have little or no notion of the capability of the machine tools exhibited until they see them actually at work, and then their advantages appeal very strongly to them. They find that there are cheaper methods of manufacture than those they are in the habit of employing, and that the makers are prepared to design and construct tools which will perform any desired class of work, and they find, moreover, at the present time that they can have American machine tools in their English shops within a fortnight after the order has been placed, whilst they would have to wait months for those of English manufacture.

There is but one other point to which we must in conclusion call attention, because it struck us forcibly at the show. That is the continual improvement in the American tools and the appearance of new designs. It shows how keenly alive the Americans are to everything which may give them the advantage, and how strong the rivalry between the different makers continues to be, and it is one of the points that the English maker, less ready in invention, will have the greatest difficulty in combating.

COMPRESSION IN STEAM CYLINDERS.

IN our last impression we placed before our readers a summary of perhaps all the practical information available concerning the effect of compression in the cylinders of steam engines. We would emphasise the word practical, because it is specially noteworthy that in this case practice and theory do not completely agree; and our purpose at present is to set forth certain considerations easily enough overlooked, which, if their utility is not obvious, are, at all events, full of interest. We have shown that the limited number of experiments which have been carried out go to prove that compression does neither harm nor good, and we now set ourselves the task of suggesting an explanation of this fact, for that it is a fact we have no reason to doubt.

In the first place, then, why should compression promote economy? The answer may be given in Zeuner's words, which we have already quoted:—"With complete expansion the effect of complete compression is to annul the injurious effect of clearance space." This is very nearly identical with Rankine's proposition. He first gives a mathematical definition of the loss due to clearance, as set forth by the equation $\frac{N\,B}{A\,B} = 1 + c\,r'$. Next giving the formula for adjusting the cushioning until the quantity of steam confined is "just sufficient to fill the clearance at the initial pressure p_1" he goes on to say, "The effect of this adjustment is to save all the additional expenditure of steam per stroke represented by $c\,r'$ in equation 5, and to save also the loss of energy per pound of steam expressed by the formula 6, so that the efficiency of the steam remains undiminished." It is well

known the less the clearance space in a steam engine the more economical is it. Now, compression is an extremely facile method of reducing clearance to nothing. It is very inconvenient in many respects to reduce clearance mechanically; and it is even dangerous when we work pistons within an eighth of an inch of the cylinder covers. But by filling the waste spaces with exhaust steam, we get rid of all clearance so far as the incoming steam is concerned. Furthermore it is sometimes argued that compression so far raises the temperature of the compressed steam, and with it of the cylinder walls, that initial condensation is prevented. It would extend this article beyond reasonable limits were we to attempt to discuss this part of the problem fully. It is enough to say that we content ourselves with Zeuner's proposition. No one, indeed, of any authority has attached importance to the rise in temperature brought about by compression. It is fortunately possible to attach some definite values to what is going on in the cylinder of a steam engine, which values will help us to form a correct estimate as to the good or bad influence of any given degree of compression. Let us, for example, assume the case of a single-cylinder engine, such as that used by M. Dwelshauvers Dery, and say that, working without compression, it indicates 100-horse power. The leading corner of the diagram will be nearly square, and the consumption of steam 20 lb. per indicated horse-power per hour. Next, let us assume that, other things remaining the same, we so alter the action of the exhaust valve that we cut 10 per cent. out of the area of the indicator diagram at the leading corner. The indicated horse-power of the engine is now 90. When it was 100 the engine used 2000 lb. of steam per hour. If the compression is to do any good, it is clear that the consumption of steam must be less than 1800 lb. That is to say, cutting out 10 per cent. of the diagram must effect a saving of more than 200 lb. in the weight of steam used, or nothing is gained. Now is there any reason to conclude that this result can be obtained? But before we attempt to answer this question, we must point out that the loss of power postulated may be inadmissible. The consequence will be that the ratio of expansion will have to be reduced. A bit will have to be added to the top of the diagram to compensate for that cut out at the leading corner, and this may bring about at once a direct waste of steam. Again, on the other hand, let us assume that 90 horse-power will suffice. Then may we not do more to reduce the consumption of steam by cutting off a little earlier, and so reducing the area of the diagram, than we can effect by increasing the amount of compression until the power is the same? In other words, seeing that compression reduces the indicated horse-power, other things being equal, the ratio of expansion must always be reduced as this compression is augmented, steam being cut off later and later in the stroke as the compression becomes greater and greater. It is enough to state these things to show how complex the whole subject is, and how numerous its ramifications, and how many reasons may be brought forward to show that cushioning is not necessarily a means of saving steam.

We may now turn to Professor Zeuner's proposition, and consider whether we are or are not justified in regarding it as quite true of a real steam engine. There can, we think, be but one answer to this. The proposition is not true of real engines. It is, of course, based on the theory that the work expended in compressing the steam retained in the cylinder will be all given back by the same steam during expansion. This can only be true, however, if the negative efficiency of the steam during compression and the positive efficiency of the steam during expansion are the same. Let us suppose, for example, that a pound of steam per stroke is retained in the cylinder, and the work of compression on it is represented by x. But the value of x will depend on the initial and terminal pressures, that is to say, on the ratio of what we may term inverted expansion. This, however, may bear but the most remote relation to the actual ratio of expansion during the working stroke of the piston. Calling the efficiency during expansion y, we can see in a moment that unless y is equal to x there can be nothing gained by compression, and that if x is greater than y compression may result in a dead loss instead of a gain. But this is not all. It is obviously impossible that more work can be got out of the cushioned steam during expansion than was expended in compressing it. It seems to be a well-established law that it is impossible to carry out any physical process without a dissipation of energy. If we shut up a pound of air in a cylinder and compress it, it will not during expansion give back all the work expended in compressing it. If this is true of a nearly perfect gas like air, it is a hundred times more true of a fluid at or about the critical point like steam. Indeed, it is well known that if there is a good deal of water in the cylinder it is impossible to raise the compression pressure beyond a certain limit, any attempt to do so simply resulting in liquefaction—a phenomenon manifesting itself in indicator cards in a way to much perplex the unwary student now and then. As to what occurs in a cylinder during compression very little is known; but it is, at all events, certain that the work expended in compressing the steam can never be all returned during expansion. There remains, then, only the abolition of clearance to be credited to compression; what this may be worth is a very open question. It is evident that an engine with very large clearance spaces ought to be improved by compression to a far greater extent than would be possible in the case of an engine with small clearances; but there is no certainty that this proposition must always apply.

Nothing has been said about compression in compound engines. There is, however, no room to think that its effect will be materially different, whatever the number of cylinders used, at all events, so far as the high-pressure cylinder is concerned; both the others work with maximum clearance in the sense that the receivers become *ipso facto* part of them twice in every revolution. It has been found in the case of racing portables that it is conducive to economy to work with a square admission corner to the diagram, compression doing more harm than good, whether the engine is compound or simple; and it must not be forgotten that the brake horse-power always bears a higher proportion to the indicated as the compression becomes less, the internal friction of the engine being reduced. The relations existing between jacketing and compression appear to deserve very careful investigation. There is not wanting—as we have had occasion to say before now—testimony to the effect that the greater the compression the greater the utility of the steam jacket.

It will be seen that we have, both last week and now, avoided the theory of the steam engine, and we have done so of set purpose. We do not believe that any theoretical investigation of compression yet published is consistent with the results obtained in practice. The theory fails, whether it is Zeuner's, or Dery's, or Rankine's, or that of anyone else, not because it is essentially erroneous, but because it is based on incomplete data. If we knew precisely what takes place in a cylinder during compression, it would be possible to apply thermodynamic laws, and formulate our information. As matters stand, however, the facts are not to be had. The interchange of temperature between the steam and the metal, the weight of water present, and so on, are all unknown factors. Even about so essential a thing in this connection as the temperature of compressed steam the world is very much in the dark. The sum of our knowlege at present appears to amount to this—that compression is not an adequate substitute for the mechanical reduction of clearance space; that in high-speed engines it is useful, if not essential, to prevent knock, and that in slow running engines it may easily be carried to the length of causing very objectionable stresses in the engine, with irregular working, knocking and even broken brasses.

TRADE AS IT IS.

Whatever may be said as to condition of the trade generally of Great Britain, and as to whether it is or is not, as a whole, satisfactory, there can be no doubt whatever that the iron and steel trade is in an extremely prosperous condition. Maker after maker, when questioned, asserts that he does not know which way to turn to get his orders out in time, or reasonably to time, so overwhelmed is he with work. This state of things is by no means confined to this one branch of the trade. In every direction it is the same; its sister trade, for example, that of coal mining, follows suit, and not only are existing pits hard at work, but new pits are being sunk in many parts of the country. Naturally, therefore, makers of winding, hauling, pumping, air-compressing, and fan engines, are hard at work also. Then, to turn to an entirely different branch of engineering, that of traction, whether by steam or electricity, the same story is told. Locomotive engine builders state that they are five months behind-hand, and that unless customers are willing to wait two years for engines they cannot accept any more orders. Electric traction is taking an increasing hold upon this country. To understand to what extent, it is only necessary to pay visits to almost any of the shops of the larger manufacturers of electrical plant, or to those of the engine builders who have devoted themselves to this particular subject. In the first will be found such an immense number of machines in different states of progress that it is difficult to understand where so many can be destined for, and in the engine-makers' shop one is hardly able to pick his way about, so numerous are the parts of engines in course of construction, and so much space do the combined sets of dynamos and engines take up when erected for testing purposes. Without any doubt there is great activity in both these branches, but they are by no means isolated instances. Take, for example, the manufacturers of mining tools for abroad—America, Canada, Australia, and Africa—their works are overcrowded. The search for diamonds and gold and other precious metals is going on more keenly now than ever before, and the tools for mining them are made in the engineering workshops of Great Britain. Gas and oil engines, too, are very much in request, makers having their hands entirely full. Blast furnaces everywhere are in full operation. Large cranes for dock, harbour, and other work at home and abroad were never so much in demand. The shipbuilding business is, to say the least of it, brisk, many of the ships in course of construction being for foreign countries, thus bringing more money into this country. Large numbers of manufacturers are extending their works—many of them very considerably—and there is a great tendency, not only in the new works but also in the older establishments, to employ electricity. This power is being used in various ways, very largely for overhead travelling cranes, which are being made in sizes from 50 up to 80 tons capacity, nearly all of them with three motors, and in many instances electric motors are being used for driving shafting, or more rarely, for driving single machines.

Everywhere there are evidences of self-acting machinery taking a prominent place to simplify work, and reduce the amount of hand labour, and the number of "settings." This policy has no doubt been forced upon the manufacturers in consequence of the late strike and in self-defence. Things are turning out exactly as we predicted that they would. We pointed out at the time that the men could not possibly gain their point, and would probably lose even what little they had by striking, and such has proved to be the case. There are countless instances to be found now all over the country of men who were but a short while ago labourers now looking after machine tools; perhaps two or more of them, and earning good wages, and of lads doing fitters' or turners' work, and doing it well, too, and earning men's wages; whereas, till the strike, they were only doing boys' work and earning boys' wages. There is yet another sign that the results of the strike have been more beneficial to the masters than to the men. We are credibly informed by more than one manufacturer that since the strike the same men have done more work for the same money, and in the same time, than they did before. This, no doubt, is caused by what the masters found out while the strike was in full swing, namely, that with a few earnest workers — boys, apprentices, and draughtsmen—they could get on with half the hands previously found indispensable. Naturally when such of the men as were taken on again—and many were not—returned to work, this extra amount was not only expected but obtained.

Of course, some of the crush of work which now obtains in nearly every engineering shop—and in most of the shops a night shift is being worked—is due to the time lost during the strike. But this will not account for it all. There is a healthy activity everywhere present. Not a day passes that we do not hear of some new gigantic engineering work to be entered upon, some new ships to be built, or waterworks, &c., constructed, and, as a natural consequence, the iron trade flourishes. Pessimistical writers will always abound, no matter how prosperous the times; but how many of these have seen the actual manufactures in progress? Let them make a tour of inspection, and then let us hear if they can harp upon the same string any longer. Great Britain need not fear foreign competition, at present at all events. There will always be found a market for her goods, for the world is wide, and as long as her present standard of excellence is maintained there will always be buyers. What she has got to fear, though, is herself, labour troubles and disputes between masters and men; though after the late discovery by the masters of the immense strength of unity, we personally have no fears that Britain's position as an engineering country is threatened in the least degree.

AVOID STRIKES.

We are admonished that "a word to the wise is enough." Such a word we wish just now to tender to the iron and coal, the shipbuilding, the engineering, and the general metal trades. It has reference to the supreme importance at the present juncture of avoiding anything in the shape of trade disputes or strikes. Our words are therefore addressed as much to the operatives as masters, and we trust they will be received by both in the same spirit of cordial good will and belief in our disinterestedness as that in which they are tendered. The trade of our country has arrived at a critical stage in the period of revival which has now happily been developed. Prices in the iron and steel and metal markets, such as copper, tin, spelter, &c., are still steadily rising. Not only so, but the lighter metalliferous industries of the kingdom which come under the generic term of hardwares, are all advising advances in quotations. Demand both on home and export account is distinctly on the up-grade, and orders are coming in at the works with a buoyancy and freedom such as has not been noticeable for many a day. So improved, indeed, is business looking all round, and so well sustained have been the first beginnings of the revival, that in many directions traders are now beginning to prophesy that we have a two-years' trade revival ahead of us. Certain of the iron and steel districts and the shipbuilding yards are most conspicuous in the confidence with which they utter this prognostication. It is just here where the word of warning and caution we wish to tender comes in. It is most necessary for its success, not only that the revival should be started on a sound basis, such as we believe now fully exists, but that having once steadily begun there should be no hindrance nor interruption of its expansion and extension by troubles with the workpeople. Happily, the interference which at one time threatened on the political horizon has now cleared, and there seems little occasion to fear that the trade improvement will be spoiled by any outbreak of war. It is equally desirable that we should be insured against labour wars for the next year or two. The re-arrangement, upon a stronger basis than ever of the Employers' Federation in the engineering and allied trades, is an event certain to minister to a continuance of industrial peace in the engineering industry. On several sides in other industries a disposition is, we notice, being shown by the employers to meet the men in an amicable spirit in any demands they may just now make for increased wages arising out of the trade revival. This is as it should be; the step is a wise one, and in the best interests of the country's commerce we desire to plead for a continuance of this policy. Producers' motto for 1899 should be "Avoid Strikes."

LONDON LOCAL AUTHORITIES AND THE WATER-SUPPLY QUESTION.

In considering the question as to the future ownership or control of the water supply of the metropolis, it is a little surprising that the Vestries and District Boards, between forty and fifty in number, have been left almost entirely out of consideration. What their respective opinions are on the subject no one seems to have known or to have cared, and it has been left to the Battersea authority, of all others, to discover what views are held by these different bodies. The Battersea Vestry, which at other times one would hardly regard from a serious standpoint, has in this particular case been the means of eliciting some valuable information on the London water-supply question by the initiation of "a crusade against the water companies with a view to the control of the water supply being vested in the people of London." It has been in pursuance of this object, with which we are not for the time being concerned, that it was thought advisable in the first instance to obtain the opinions of the Vestries and District Boards as to whether (1) they were in favour of the water supply being vested in a public authority; (2) if so, in what authority, and how it should be constituted; and (3) whether they were prepared to assist in the promotion of a Bill in Parliament to deal with the question. The result of the investigation, whilst it will scarcely have the effect of checking the futile "crusade," must have astonished even the Battersea Vestry, the members of which received a summarised report on the subject with as much indifference as if their labours had been brought to a fruitless conclusion. This report shows that twenty-two of the Vestries and District Boards are in favour of the water supply being vested in a public authority, six are in favour of control by such an authority, and thirteen reserve their opinion until the issue of the report of the Royal Commission, have taken no action in regard to the questions, have not replied,

or are opposed to the water supply being vested in a public authority, and express no other view. As to the authority to be entrusted with the water supply, it is somewhat significant that only ten authorities suggest the London County Council as the proper body, whilst as to rendering financial assistance in the promotion of a Bill, the majority of those who express an opinion on this particular point frankly declare that they have no legal power to do so. The Vestry of Battersea cannot do better than forward a copy of the report to each of the members of the Royal Commission on the London Water Supply.

THE LIVERPOOL MOTOR WAGON TRIALS.

ON another page we are enabled to give, in an abbreviated form, the results of the motor wagon competition which took place in May last at Liverpool, under the auspices of the Self-Propelled Traffic Association—a body which has now become amalgamated with the Automobile Club. For these particulars we are indebted to the very excellent and complete report just published, a copy of which should be on the bookshelf of every one interested in the subject of self-moving vehicles. The book comprises over 100 pages of letterpress, interspersed with excellent illustrations, not only of the vehicles which took part, but also including reproductions of snapshots of the scenes along the routes traversed. Much praise is due to the judges and observers for the manner in which the trials were carried out, and to the organising secretary, Mr. E. Shrapnell Smith, who has also edited the report. We might here be allowed to call attention to the onerous legal conditions involved in complying with the limitations of the Locomotives on Highways Act, 1896. The limit of three tons tare, imposed by this Act, had the effect of preventing French builders from sending over any vehicles to take part in the competition, and it is questionable whether a really satisfactory wagon can be built with this tare to carry a load of, say, five tons. It is to the organisation of such trials as these that we must look for assistance in removing legal obstructions and placing this class of traffic on a footing which will stimulate the new industry.

LITERATURE.

The New Roadmaster's Assistant. A Manual of Reference for those having to do with the Permanent Way of American Railroads. By GEORGE HEBARD PAINE. Published by the *Railroad Gazette*, 32, Park-place, New York. 1898.

THOUGH it may be true that the present little volume is more especially adapted for use on American railroads than on those of other countries, as modestly assumed by the author, yet there is a large portion of its contents of a much more comprehensive scope. English engineers are thoroughly conversant with such substitutes as "tracks" for lines, "cross-ties" for sleepers, "bumping posts" for buffer stops, and many other synonymous terms. The first two chapters are devoted to the organisation of the permanent way staff, rules for the management of the employés, a definition of the methods of work to be adopted, and a statement of the proper times and seasons at which works of a different character should be undertaken. In outside districts the old timber post and rail, or post and stretchers principle, is still employed, but they are both fast being superseded by steel wire, in one or other of the forms known as "woven." For stations and for fencing in the track when passing through towns, "expanded metal," the "*métal déployé*" of the French engineers, constitutes an excellent and durable protection. It is becoming to be well understood that when it is a case of building extensive and important lines, calculated for the continuous running of heavy traffic, it is cheaper in the long run not to grudge a liberal expenditure of funds, preserving always the golden mean between parsimony and extravagance. Stations, both passenger and goods, admit of numerous varieties, since the buildings and fixtures belonging to them will depend upon the size and shape of the available site; and also in goods stations upon the nature of the commodities entering and leaving the depôt. We are not nearly so much concerned with the question of level crossings, their gates, and the methods for opening and shutting them, as are our American friends, since, except in country districts, their use is practically tabooed both by the Board of Trade and the public generally.

While the quality of the water supplied to locomotive boilers is perhaps hardly included in the repair and maintenance of the permanent way, yet it is a matter which calls for serious attention. Frequently, however, all that can be done under the circumstances is to endeavour to select where possible a water tolerably free from lime and mud, which are the commonest impurities met with. There is no remedy economically available for the first of these defects, and the boilers suffer for it in consequence; but the second can be very much mitigated by permitting the water to settle for some time before passing it into the locomotives. The thorough drainage of the track is of paramount importance, and nothing contributes more to ensure the absence of stagnant water—its greatest foe—than ditches of sufficient dimensions, and those ditches maintained in a constantly clean and unencumbered condition. This latter essential is often greatly neglected on all lines, and in some instances to such an extent as almost to lead to the conclusion that the ditches, once made, were afterwards left to take care of themselves. The reader will find in Chapter VI. a full description of different ditching methods, including those operated by ploughs and compressed air machines, as well as of the drainage of the slopes of both cuttings and embankments by pipes, tile drains, and the cutting of trenches. Almost any description of granite or limestone will make good ballast, but the softer kinds of sandstones and rocks of a shaley or clayey character are not suitable. Mr. Paine classes the different materials used for ballasting in the following order of merit—broken stone, clean coarse gravel, furnace slag, engine cinder, and clean sand. When these are all unattainable, or, if procurable, too expensive to be used, recourse must be had to burnt clay, which has been tried by ourselves on a tolerably large scale, and has been found to answer fairly well, although inferior to broken stone or gravel. Burnt clay has two chief defects—when hard, its hardness is not uniform, and even at its best it fractures and disintegrates too easily.

There has always been a diversity of opinion among railway engineers respecting the rival claims of broken stone and gravel to the first rank as ballasting material. Many excellent authorities consider that the greater facility with which gravel can be manipulated more than compensates for the more durable quality of the stone. The author observes, "But it seems almost certain that for roads having many and heavy trains, nothing in the end is so good as clean, broken stone," and we are disposed to agree with him.

That there is still a considerable reserve of timber for sleepers in stock is evidenced by the fact that the use of the many wood-preserving processes so common among ourselves obtains but on a comparatively small scale in America. There is no doubt considerable uncertainty, due to a variety of causes, respecting the length of time that creosoting, or any other preservative, will prolong the life of a cross-tie; but from both European and American experience it is probable that instead of being obliged to renew all the sleepers of a main line in every seven or eight years, it would be only necessary to do so in every fifteen or sixteen years, provided some efficient process was employed. Another proof of the fact that there can be no general scarcity of timber for ties in the States, is that iron and steel sleepers, which are in great demand on the Continent and in foreign countries, have been resorted to in America to a very limited extent. Track work, tools, and switches, are treated of, and the important subject of signals, interlocking levers, and mechanical appliances is done full justice to. The "New Roadmaster's Assistant" is a very handy, useful little work, well printed in good clear type, and profusely illustrated with over two hundred and fifty engravings.

SHORT NOTICES.

The "Mechanical World" Pocket Diary and Year-book for 1899. Containing a collection of useful engineering notes, rules, tables, and data. Manchester: Emmott and Co., Limited. Price 6d. net.—Some notes, tables, and data on gas and oil engines have been added to this, the twelfth, edition of this remarkable pocket-book. We know of no volume published at the price which contains so much generally useful information for engineers.

Hydraulic Tables for Finding the Mean Velocity and Discharge in Open Channels, according to the Formulæ of Bazin and Kutter. Calculated and compiled by T. Higham, C.I.E. Second and enlarged edition. London: E. and F. N. Spon, Limited. 1899. Price 7s. 6d.—Twenty-one years ago the first edition of this useful book appeared. The present issue is only a reprint of the former, except that Table V. has been expanded so as to include nine instead of three values of the coefficient N in Kutter's formula; but it will be, we venture to believe, in spite of rivals in the same field, at least as welcome as the first edition. It is capitally printed, and the use of a variety of different faced type in the tables renders errors little likely to occur in the use of them. The explanation of the manner of using the tables and the general formulæ are clear and satisfactory, and in spite of certain modifications which have been suggested in recent years, we believe will be found sufficiently accurate for all practical purposes.

Lecture Notes on the Theory of Electrical Measurements. Prepared for the Third-year Classes of the Cooper Union Night School of Science by William A. Anthony, Professor of Physics. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.—This book in its preface declares its purpose to be to furnish the student with the topics treated in the lectures, and to give in full such facts, data, and courses of reasoning as are not fully mastered by the student in the course of the lecture, while it is not intended to relieve the students of the necessity of taking notes during the lecture, especially of the experiments. As a sort of index to, or *précis* of a particular series of lectures for the use of a class of students in a particular stage of advancement, this book no doubt fully bears out the claims made for it. It is concise and correct, as far as it goes. Its restricted use is its failing, though it would be an extremely handy work of reference for masters preparing lectures on the subjects of which it treats, which include the general principles involved in electrical measurements of all kinds, with references to C.G.S. units, units of work, magnetic field, electric current and potential resistance, electrolysis, magnetism, &c. A word of praise, too, must be given to the extreme clearness of the printing, and the careful preparation of the few simple illustrations. These are in advance of those of most books of this class.

BOOKS RECEIVED.

The Royal Navy List Diary and Naval Handbook for 1899. London: Witherby and Co. Price 3s. net.

L'Alluminio. Del Dottor Carlo Formenti. Con 67 figure e 21 tavole. Milano: Ulrico Hoepli. 1899. Price L 3·50.

On the Springing and Adjusting of Watches. By F. J. Britten. London: E. and F. N. Spon, Limited. 1898. Price 3s. net.

Nichelatura, Argentatura, Doratura, Ramatura, Metallizzazioni. Dell'Ing. J. Ghersi. Milano: Ulrico Hoepli. 1899. Price L 3·50.

The Institution of Junior Engineers: Record of Transactions. Vol. vii. Sixteenth Session—1896-97. Edited by Walter T. Dunn. London: Published by the Institution. Price 10s. 6d.

The Tutorial Algebra, Based on the Algebra of Radhakrishnan. Part II., Advanced Course. By Wm. Briggs, M.A., F.C.S., F.R.A.S., and G. H. Bryan, Sc.D., F.R.S. London: W. B. Clive. Price 6s. 6d.

Sanitary Engineering: A Practical Treatise on the Collection, Removal, and Final Disposal of Sewage, &c. By Colonel E. C. S. Moore, R.E. With 534 illustrations and 70 large folding plates. London: B. T. Batsford. 1898. Price 30s. net.

The Law and Practice under the Patents, Designs, and Trade Marks Acts, 1883 *to* 1888. *With the Practice in Actions for Infringement of Patent, and an Appendix of Orders made in Patent Actions, and Forms.* By William Norton Lawson, M.A. Third edition by the Author, assisted by Charles Sharp and Marshall Denham Warmington, M.A. London: Butterworth and Co. 1898.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Engineers: George T. Goodall, to the Victory, for the Hardy, and A. W. Bolton, to the Victory, for the Violet. Assistant Engineers: Henry T. Canning, to the Pembroke, for the Pactolus; Henry W. Grant, to the Howe, and John S. Hare, to the Pembroke, for the Pegasus; Frank R. Goodwin, to the Terrible (tempy.), and W. G. G. P. Lumsden (proby.), to the Victory, for the Europa; Francis Magrath, to the Pembroke, for the Perseus. Probationary Assistant Engineer: Jonathan J. Screech, to the Proserpine.

THE FRENCH NAVAL ESTIMATES.

M. LOCKROY has apparently fallen in with the views of experts who argue that the only way of combating England with success is to build light and swift cruisers which will be able to wage war upon the carrying trade, and thus reduce this country to inaction by destroying commerce, for in the list of new vessels which he proposes adding to the French navy, he has comprised specimens which will no doubt satisfy every theorist who has his own ideas on the matter. The list includes seven battleships, thirteen cruisers, six station cruisers, two cruisers of a new type that are evidently intended to serve as scouts—the utility of which is being severely criticised in some quarters—one aviso, two gunboats, one transport, eight submarine boats, twelve torpedo destroyers, one sea-going torpedo boat, ten squadron torpedo boats, thirty-nine first-class torpedo boats, and six small torpedo boats. Of these vessels thirty-seven will be built in the State dockyards, and the rest in private yards. Sixteen of the ships in the list are either practically complete or will be at the beginning of next year—that is to say, the battleships Charlemagne and Gaulois, the first-class station cruiser Guichen, the second-class cruiser Protet, the aviso Kersaint, which has been on the stocks so many years that it is now thoroughly out of date; the destroyers, Dunois and Durandal, the sea-going torpedo boat Cyclone, which has recently exceeded thirty knots in its trials at Cherbourg, and nine first-class torpedo boats. Of the remaining seventy-two vessels, forty-four are either on the stocks or will be by the end of the year. In his statement, M. Lockroy says that both the Saint-Louis and the D'Entrecasteaux will be completed in 1899; but, as a matter of fact, the latter vessel is already completing its armament, and will start for the Chinese seas very shortly. The other ships to be finished next year are the first-class cruiser Chateau-renault, the third-class cruisers D'Estrées and Infernet, eight destroyers, a gunboat, the submarine boat Morse, seventeen first-class torpedo boats, and six small torpedo boats. The vessels to be completed in 1900 are the battleships Henry IV. and the Iéna, the first-class cruiser Jurien-de-la-Gravière, a gunboat, a submarine boat, and six squadron torpedo boats. In 1901 are to be terminated the battleship Suffren, the protected cruisers Jeanne d'Arc, Dupetit-Thouars, Condé, Montcalm, Desaix, and Kléber; and in the following year it is announced that the cruisers Gueydon, Gloire, Dupleix, and Sully, will be ready to take the sea. The number of vessels to be put on the stocks in 1899 is twenty-eight, including a battleship, of which the drawings have not even yet been completed, and it is doubtful even whether a definite type has been decided upon; two protected cruisers of the Gloire and Sully class, two estafette cruisers, two destroyers, six submarine boats, four squadron torpedo boats, and eleven first-class torpedo boats. The cruisers of the Gloire class will have a displacement of 10,014 tons, with a length over all of 138 metres, and a beam of 20·20 metres, and will be propelled by three screws. The speed is to be 21 knots. Carrying 1590 tons of coal, they will have a range of action of 1940 miles at the maximum speed, and of 10,400 miles at 10 knots. They will have two 194 mm. guns, eight of 164·7 mm., six of 100 mm., eighteen of 47 mm., six of 37 mm., and two of 65 mm. The estimated cost of these two vessels is 21,715,641f. and 23,573,500f., the difference being due apparently to the fact that one will be constructed in the State yards and the other by a private firm. The two estafette cruisers, which are of an entirely new type, will have a length of 120 metres, a beam of 13·60 metres, and a displacement of 4000 tons. They will have water-tube boilers, and the engines will develope 15,000-horse power. The estimated maximum speed is 23 knots. They will have eight guns of 100 mm., twelve of 47 mm., and four of 37 mm., all quick-firing. The estimated cost is 8,766,468f. and 8,731,518f. respectively. It will be remarked that the submarine torpedo boats of the type of the Narval, now building at Cherbourg, figure prominently in the estimates, and it appears as if the French Marine have a good deal of confidence in the efficiency of this class of vessel. The six boats to be constructed will have a displacement of 106 tons. They will be propelled by engines of 217-horse power, and the estimated speed is 12 knots. They will have no other armament but four torpedo tubes. The cost of each boat is 648,050f. The grant M. Lockroy has asked for to cover the year 1899 is 304,078,400f., a matter of 17,000,000f. more than for the present year.

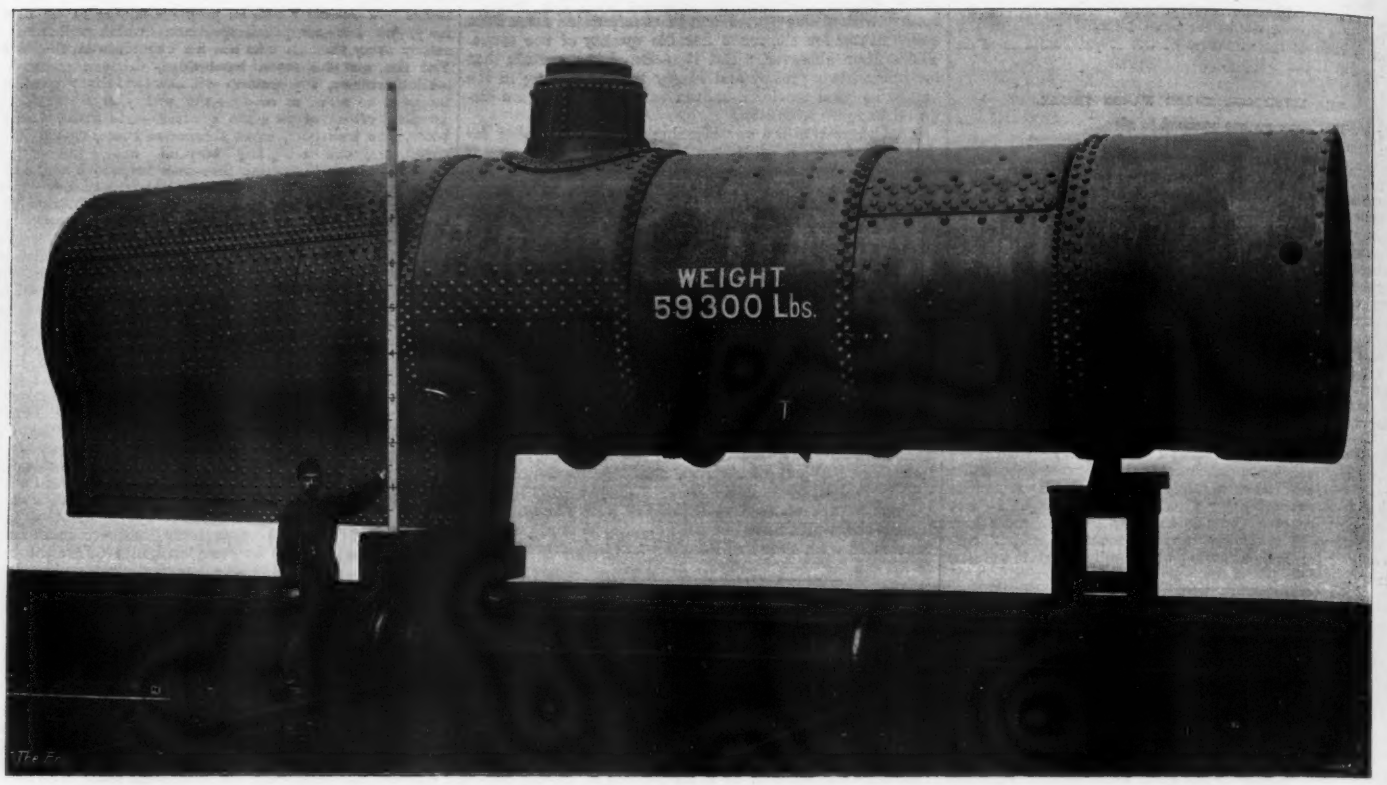
EXPLOSIONS IN SEWERS.

ATTENTION is drawn to the discharge of dangerous substances into sewers by the report, just published, of the Main Drainage Committee of the London County Council on the subject of the recent explosion at the Abbey Mills Pumping Station. There seems to be no doubt whatever that the explosion, which did considerable damage, was due to the ignition of a mixture of petroleum vapour and atmospheric air. That such an accident is possible is by no means a pleasant thought, for men with naked lights, or what are practically so with respect to explosive mixtures, are patrolling day and night the sewers which are underneath the roads on which we walk, and an explosion may occur at any moment if petroleum vapour be present. Still, though the chances must be very greatly against such a thing happening, save in the immediate vicinity of a petroleum factory, we consider that the Council would be acting most wisely if they prevented anyone engaged in the distillation of petroleum from letting refuse run direct into the sewers, for such it would appear was the original cause of the accident. It is difficult to understand how anyone should wish to throw away anything which could give off at ordinary atmospheric temperatures sufficient vapour of petroleum to cause an explosion such as this, by which, we understand, a roof was blown off and plate glass windows in an adjoining engine-house broken, yet it seems as though it were quite a usual thing for such refuse—the refuse from stills used in the process of redistilling petroleum spirit—to be allowed to run directly into the sewers, and the result has been not only the explosion in question, but also several others of varying intensity in the same neighbourhood. Surely, to look at the matter simply from the commercial point of view, a substance which will yield sufficient vapour to make an explosion is too valuable to throw away.

WITHIN a radius of 12 miles of the London General Post-office there are 418 railway stations, and within a circle having a radius of 6 miles there are 275 stations.

THE BOILER OF THE LARGEST LOCOMOTIVE IN THE WORLD

MESSRS. THE PITTSBURGH LOCOMOTIVE AND CAR WORKS, ENGINEERS

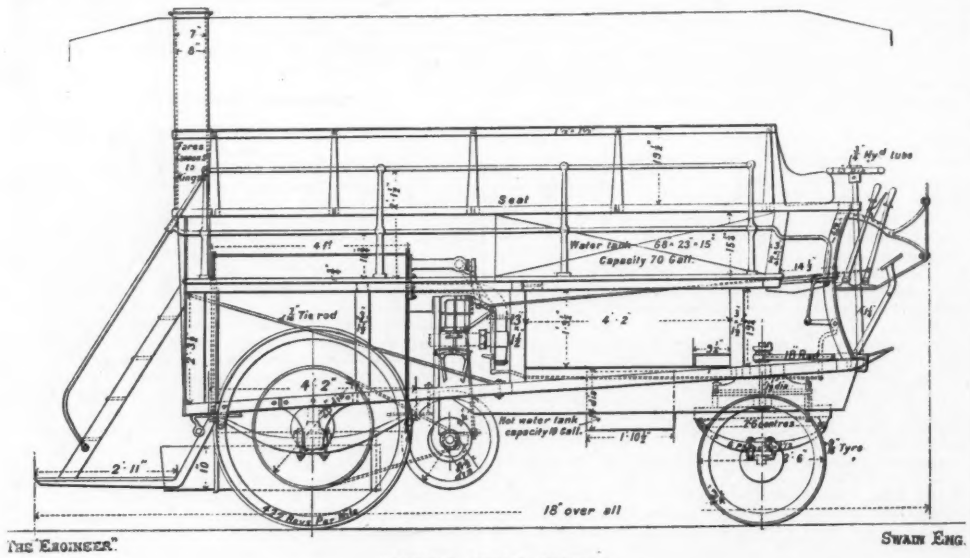


THE LARGEST LOCOMOTIVE IN THE WORLD.

WE gave on November 11th some illustrations and a full table of principal dimensions of a huge consolidation locomotive recently constructed by the Pittsburgh Locomotive and Car Works. We feel sure that the illustration of the boiler, which we engrave above, will be regarded with interest. It is made of Carnegie steel plate, $\frac{7}{16}$in. thick, and intended for a working pressure of 200 lb. The largest diameter of barrel is 83$\frac{1}{2}$in., the smallest 74$\frac{3}{8}$in. The fire-box is 10ft. long by 3ft. 4$\frac{1}{2}$in. wide, and there are 355 tubes, 2$\frac{1}{4}$in. diameter and 15ft. long.

MARTYN'S LOCOMOTOR CAR OR STEAM OMNIBUS.

WE illustrate below one of the latest forms of steam carriage for common roads, which has within the last few weeks been constructed by Messrs. David Martyn and Co., Limited, Glen-street Engine Works, Hebburn-on-Tyne. The managing director of the concern, Mr. David Martyn, has for several years devoted a considerable amount of attention to the designing of vehicles of this description, and the results obtained during the trials of his latest invention—the steam omnibus just completed—have been very satisfactory. These trials have been carried out over the highways in the vicinity of Hebburn, and have demonstrated the ease with which the vehicle can be controlled, the smoothness of its running, and the small amount of vibration that is observable.



MARTYN'S STEAM OMNIBUS

The locomotor car is designed to seat twenty-two adults, but has carried on one of its trips a good many more, and it conveyed these without difficulty over gradients as steep as 1 in 15, while even steeper hills are ascended with ordinary loads. A regular speed of 15 miles per hour can be obtained. It is perfectly under control when descending hills, and indeed at any time, and can readily be steered, reversed, or stopped. The steering gear, which is constructed in accordance with a patent taken out by Mr. Martyn, is very effective; in fact, the vehicle can with it be completely turned round in a space but a few feet greater than its entire length, while corners are turned with great facility. The brakes also are powerful, so much so that when fully loaded and travelling at a speed of 12 miles per hour the car has been stopped within 25ft. to 30ft. The car is fitted with ordinary brakes to the hind or driving wheels, and band brakes to the driving drums, and the steersman can put all the brakes on at once, as well as reverse the engine in case of emergency.

The steam omnibus is 18ft. in length over all; its extreme height to the top of the chimney is 10ft., its greatest width 6ft. 3$\frac{1}{2}$in., or 2$\frac{1}{2}$in. less than the limit of width allowed under the Light Locomotives Act; while the total weight is 2 tons 19 cwt. 2 qr., or half a cwt. below the maximum permitted under the same Act. The seats are fixed lengthwise on each side of the vehicle, so that passengers are arranged back to back and about 6ft. above the ground, with the tanks, engine, and a receptacle for parcels fixed immediately underneath.

On reference to our engraving it will be noticed that at the fore-part of the car, and under the seats, is placed a water tank with a capacity of 70 gallons. It is made of galvanised iron, No. 20 gauge, with suitable stiffeners. The present vehicle has the top, sides, and ends of this tank flat, but the builders have found that when the tank is nearly empty and the omnibus is in motion, there is a rumbling noise which may be annoying to the passengers, and to prevent this they will in future cars have this tank made with corrugated sides, or as an alternative, they propose to use vegetable fibre for the tank, as it is light, clean, pliable, and cannot rust. Below this tank there is a receptacle, 4ft. long by 1ft. 9$\frac{1}{2}$in. high, for parcels, and access thereto is readily obtainable by means of four sliding doors with glass panels, two on either side. Underneath the floor of the parcels-box there is hung a small tank for the hot-water supply, and this contains ten gallons, the water being heated by a 1$\frac{1}{4}$in. iron pipe, which is passed round the boiler andtrough the combustion chamber.

Forward of the upper tank is the driver's seat, from which he controls all the movements of the car, the steam valve, the steering gear, the reversing gear, the car brakes, &c. It is noticeable that the various levers are so arranged that they are moved in the direction in which it is desired the car shall proceed. The steering gear, as is mentioned above, is not of the usual jack-in-the-box differential type, but has been invented by Mr. Martyn. It enables the driver to turn the vehicle very quickly. As part of the arrangement, the front wheels are of considerably narrower gauge than the hind ones, and in addition to this, the turning of the steering wheel puts out of gear the driving drum of the hind wheel on the inner side of the curve, so that the outer wheel has the work to do. When proceeding on the straight both wheels are doing their proper share of the work of propelling the vehicle. It will be observed that the frame of the car is inclined upwards towards the fore part, this with a view of employing larger wheels, 2$\frac{1}{2}$ft., instead of 2ft., under that part of the vehicle, so as to ease its progress over any obstructions on the road, such as loose stones, &c., and also to minimise vibration.

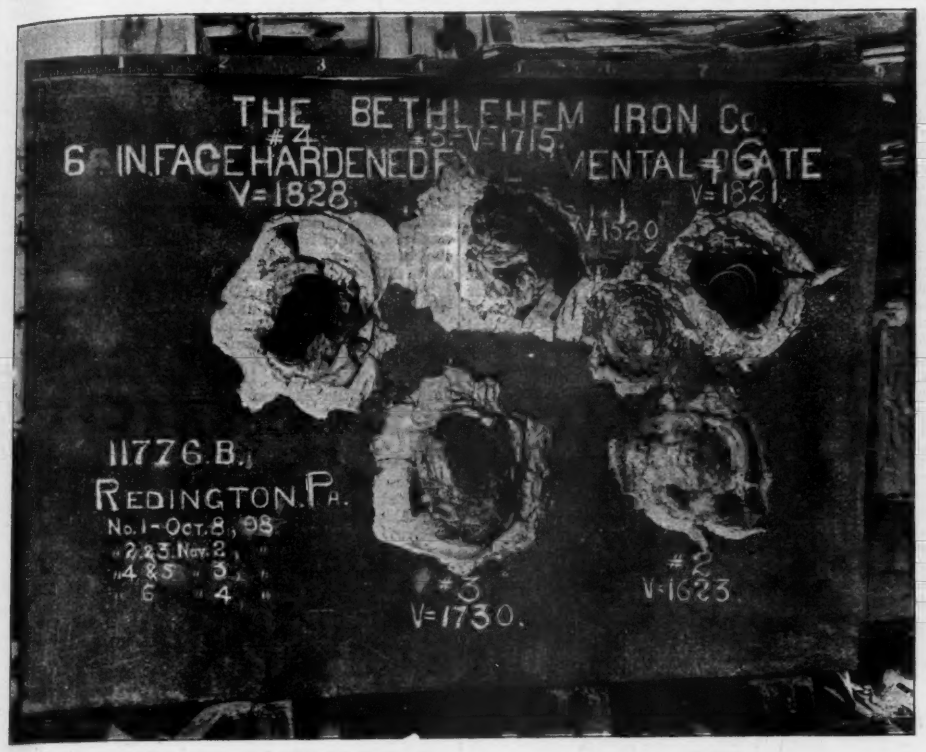
The omnibus is propelled by an engine of the high-pressure vertical type, having two inverted cylinders, each of 5in. diameter, and with a stroke of 7in., which is designed to develope 38 indicated horse-power. Aluminium, alloyed with 6 per cent. of copper, enters largely into the construction of this engine. Aluminium has for several years been employed for bed-plates, brackets, &c., but Mr. Martyn has applied it also for the cylinder covers, and he claims that he is the first to use it for this purpose. It has hitherto been assumed that the tensile strength was insufficient to warrant its employment where the temperature is considerable, but after making a series of experiments Mr. Martyn demonstrated that he could use it advantageously, though its strength decreases rapidly as the temperature increases. He does not favour its employment for steam pressures over 220 lb. per square inch.

The boiler, which is of steel, is designed by Mr. Martyn for this type of vehicle, and is one of its specialities; in fact, a patent has been taken out by him for it. It is placed as far aft as possible, is 4ft. long, and is of the fire-tube type, the fuel used being coke. It was tested to a pressure of 300 lb. per square inch, but is not worked to more than 125 lb. The efficiency of the boiler is said to be very satisfactory, as about 60 gallons of cold water can be evaporated per hour, and steam can be got up in about forty minutes. Underneath the boiler is the coke bunker. The whole weight of the boiler, engine, fuel bunker, and about two-thirds of the weight of the car itself, are borne by the axle of the driving, which are the hind wheels. Another point worth notice is that the boiler, engine, and fuel bunkers are not suspended from the car in any way—in fact, they are not connected with it except through the medium of the main axle, upon which they are hung by separate springs. The heavy weight on the hind wheels, which are of 4ft. diameter, ensures good adhesion and smoother running, and besides it altogether obviates the danger of the vehicle overturning. The safety valve is shown in the engraving, a little in front of the engine cylinders, it being inconvenient to place it in the usual position. The waste steam pipe passes into the combustion chamber, and the steam is thus superheated before it leaves the chimney, so that it is practically invisible when it emerges into the atmosphere.

The engine shaft, which is of mild steel 2in. diameter, is geared with a ratio of seven to one to each of the hind wheels of the car by means of Renolds' silent chains. A feed-pump and injector are fitted for feeding the boiler, and, should it be necessary while the car is at rest, the injector can be disconnected, and the boiler fed by means of the pump.

The chimney, it will be observed, is at the extreme end of the vehicle, so that any heat given off by it does not inconvenience the passengers. Even those sitting close to it are not affected, for the chimney is made annular, and further, is surrounded by a casing for a considerable portion of its length. Neither will the passengers who are seated above

BETHLEHEM KRUPP PROCESS PLATE



the boiler suffer from the heat, as it is so well covered with non-conducting material that the hand can comfortably be pressed upon it when it is under full steam.

The vehicle will be worked by two persons only, the driver—who is seated in front, and controls the steering, the brakes, the steam valve, &c.—and the conductor, who, besides collecting the fares, has also to undertake the duty of firing the boiler from the platform at the rear end of the car, where the passengers ascend to their seats.

In running on the ordinary highways even at full speed there is not much of which to complain on the score of vibration, certainly it is not so much noticeable as in horse-drawn vehicles on common roads, so that it is a comfortable conveyance, the minimum of vibration being secured by the engine and boiler being hung on springs independent of the car itself.

A signal bell is placed on the front of the car, and the conductor has direct communication with the driver.

It is necessary to note that the awning over the passengers' seats is only temporary, and when the car is in regular use a light permanent roof will be fixed.

The chief points in this car for which originality is claimed may be summed up as under:—The steering gear, the compensating gear, and the boiler, and for these specialities patents have been taken out, as well as for the whole car itself, while the use of aluminium for the cylinder covers is also claimed as a unique feature.

BETHLEHEM KRUPP PROCESS PLATE.

WITH the other successful results of Krupp process plates comes a remarkable one from Bethlehem. The figures in the table below speak for themselves. The photograph of the front of the plate bears them out so far as it goes. It may be seen that six 8in. shot were delivered on points, within an area of 4ft. by 2ft., that a rectangle 6ft. by 4ft. nearly covers the entire damaged portion of the plate. Under these circumstances the absence of cracking is very striking. Last week, in recording the success achieved by the Beardmore plate, we observed that the toughness of Krupp process plates could not be claimed for it, whatever its other advantages might be. We were sorry to make any such qualifying remark, but justice seemed to demand it. This result, we think, bears this out. We have to admit that the principal witness as to toughness—that is, the photograph of the back of the plate—is wanting. This we greatly regret. Nevertheless, we have evidence sufficient to bear out the conclusion that the remarkable toughness which we attributed to the Krupp process plates, on our first receiving the results of the 1895 trials, is here present. For we have a plate 6¼in. thick, attacked by six 8in. projectiles. The width of the plate is 6ft. 2in., so that when it enters deep the shot acts as a wedge, nearly one-ninth the width of the plate. The striking energy of the heaviest blow which perforated was 5842 foot-tons, or about 880·2 foot-tons per ton of plate, supposing the plate to have weighed, as we calculate, about 6 tons 12½ cwt. The heaviest blow which did not produce perforation, but whose shock was resisted, was 5229 foot-tons, or 789·6 tons per ton of plate. The absence of cracks under these conditions is to be noted. Much as we regret the absence of the view of the back as bearing on this, we also regret it because it would have been most instructive in showing how the plate yielded under the strain of complete perforation and approach to perforation in various degrees, and in what measure boring was defeated and punching made to take its place. With regard to perforation, Round No. 3, when the shot's point reached to a depth equal to the thickness of the plate—that is 6¼in.—and No. 6, when the projectile got through, but broken pieces remained in the backing and plate, fix the maximum resistance or figure of merit as something between 2·46 and 2·56. That is to say, this is the relation of the thickness of wrought iron that the shot is calculated to perforate by Tresidder's formula to the actual thickness of this plate. Lieutenant Meigs who has kindly furnished us with these results, gives it in the form of relation of steel, which by De Marre's formula would be perforated to the actual plate's thickness, a ratio which he makes 1·56 and 1·65 for rounds 3 and 6 respectively. We dislike this system, because we regard steel as such a variable substance that in spite of De Marre's preference for it—a preference which we must own has been also expressed by Vickers—we question if a practical standard can be thus furnished. If practical investigations were to be undertaken to-morrow, could any one make sure that they had this, or rather, either of these qualities of steel, for we doubt their being the same? On the other hand, although wrought iron may be a rough standard, any one in any armour-plate manufacturing district in the world could obtain it.

We naturally ask, finally, is there anything to qualify the weight of the results here given? It is to be noticed that the trial took place not at Indian Head, the Government proving ground, but at Redington, which is, we suppose, the proving ground belonging to Bethlehem. Hence we are justified in assuming this to be not only a champion plate, but probably the selected result of all champions. Bethlehem, however, may very well be content to allow this in taking their stand on such a result. With regard to the shot, our constant difficulty comes up. Holtzer shot are very good if fairly taken. The Holtzer 6in. shot that we always feel called upon to discount are those delivered before 1889, and repudiated by Holtzer as made before the introduction of hard-faced plates. At the same time, having seen some indifferent Holtzer 8in. shot used in America, we should be glad to have some definite information as to these; and we can only again repeat our wish that we could get some standard shot adopted, and one sample fired in every plate trial. The data of the trials are as follows:—

Results of Bethlehem-Krupp Process Plate attacked at Redington in October and November, 1898.

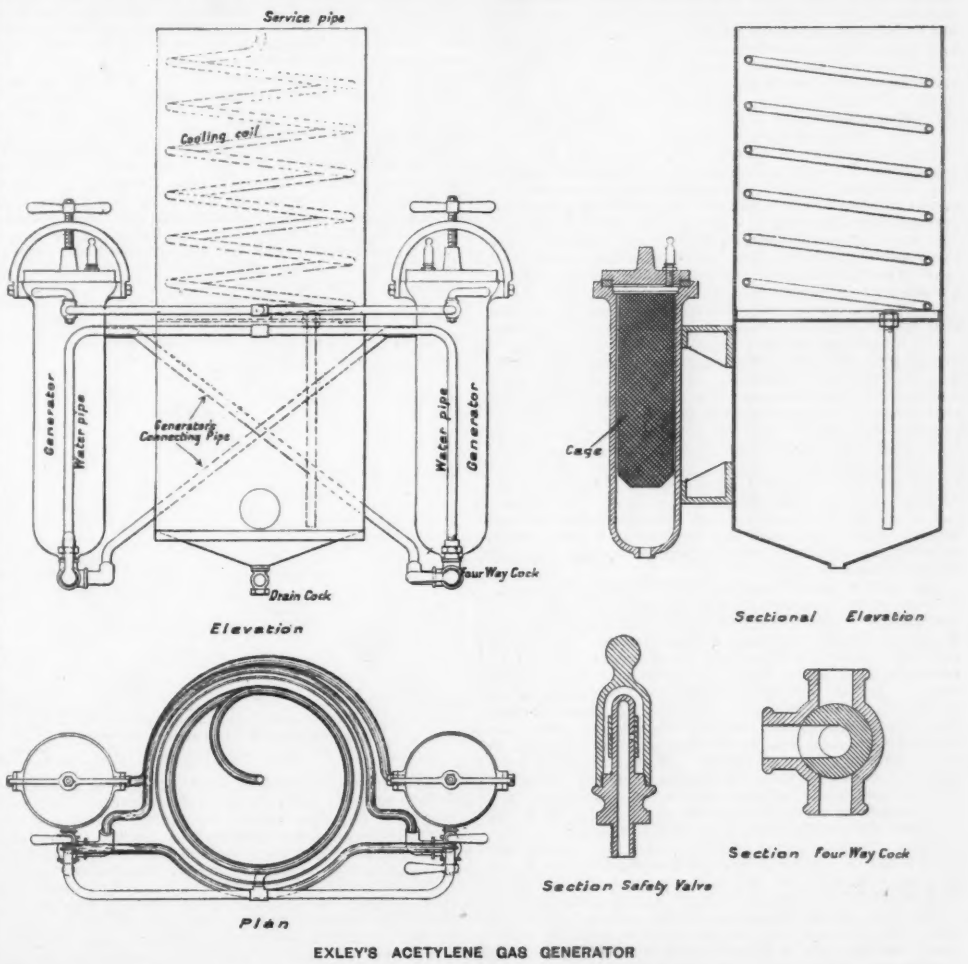
Number of round.	Date, 1898.	Shot, 8in.	Weight of shot, lb.	Striking velocity, foot-seconds.	Penetration, inches.	Perforation of iron by Tresidder, inches.	Relation of calculated perforation to thickness of plate.	Striking energy, foot-tons.	Striking energy per ton of plate, foot-tons.
1	Oct. 8th	Holtzer ..	250½	1520	¾	12·6	2·02	4013	694·5
2	Nov. 2nd	„ Midvale	252½	1624	2½	13·9	2·22	4618	635·8
3	„	„ „	252	1780	6¼	15·4	2·46	5229	789·6
4	Nov. 3rd	„ „	252½	1828	through	16·7	2·67	5842	880·2
5	„	„ „	252	1715	5	15·1	2·42	5139	774·1
6	Nov. 4th	„ „	252¼	1821	*	16·0	2·56	5799	873·

* Through, pieces lodged in plate and backing.
The plate measured 9ft. by 6ft. 2in. by 6¼in.

ACETYLENE GAS GENERATOR.

WE have recently seen in operation one of Messrs. Exley and Co's.—of Huddersfield—acetylene generators, and we give herewith sketches of it. The receiver is a vertical cylinder, having two compartments with a diaphragm across the middle. The upper portion is open and is called the cistern, and contains a coil for condensing purposes. The lower portion, called the receiver or holder, is fitted with a dished bottom and drain tap; it has also a dip pipe through the diaphragm, reaching nearly to the bottom, this pipe being open at both ends. This form of construction is what is known as a displacement holder. The generators are fitted on each side of the holder, and the water passages from the highest point of the holder connect to the lowest point of generators.

Pipes or passages are also provided to connect the upper part of each of the generators with the lower part of the other; consequently when these passages are open and the one generator is exhausted, the passage between it and the other generator is open, and the water through the first generator flows down this passage into the second generator, and the generation of gas is continued. These water passages are controlled by a four-way cock at the bottom of each generator, regulating the flow of the water either direct from



EXLEY'S ACETYLENE GAS GENERATOR

the holder or from the overflow of the other generator as required. The object of this arrangement is to enable one generator to come into use automatically when the other is exhausted; this is determined entirely by the two four-way cocks and can be arranged, so that the generators are alternating. The gas is conducted from the top of generators into a condensing coil in the cistern above; this coil is partially submerged in water, from thence the gas passes through a governor into a service pipe.

Another important advantage claimed is safety from any undue pressure, seeing that the holder itself is water-sealed only. The condensing arrangements are very ample, and have a gradual fall from the highest point of machine to the bottom of the generators. The little safety valve, of which a section is given, will be found interesting, as it is nothing more nor less than a Dunlop tire valve, the resistance of the rubber being sufficient to maintain the requisite pressure.

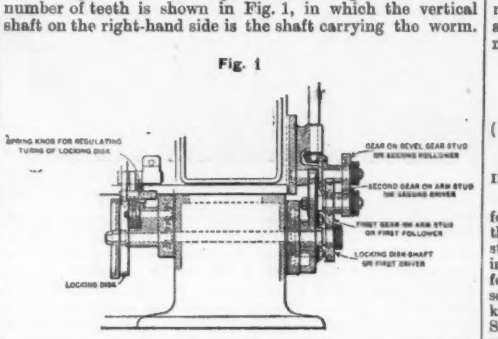
MACHINE TOOLS AT THE STANLEY SHOW.

We refer in another place to the general points in connection with the exhibits of machine tools at the Stanley and National Shows which struck us on the occasion of our visits. We should like here to be able to give our readers detailed particulars of the more interesting of these machines, but we have unfortunately been unable to obtain such drawings and illustrations of the newest of them that would make our descriptions really valuable. We must, therefore, for the present, content ourselves with drawing attention to the main features of interest, hoping that before very long we shall be in a position to give engravings of some of the tools. This is particularly so with regard to a new shaping machine which was shown on Messrs. Charles Churchill and Co.'s stand. It is made by the Potter and Johnstone Company, of Pawtucket. The table rotates about a very large pin, or rather cylinder, and can be clamped instantly in any position. The pin is of such dimensions as to remove the slightest chance of vibration. There is also a very simple and ingenious adjustable down-feed motion. On one of the fixed slides in which the ram slides there is attached a piece of metal, having its central part parallel to the line of motion of the ram and its two ends bevelled away. Through the ram head passes a rod pressed in the direction of this cam piece by a spring. As the ram moves backwards and forwards the end of this rod engages with the bevelled ends of the cam piece, and is thus caused to reciprocate. Its central part passes close to the lower end of the down-feed screw, to which it gives rotary motion through the medium of suitable mechanism. This gear does not interfere with the usual down hand-feed, which is performed in the usual manner by a hand wheel, and the amount of feed can be varied very simply whilst the machine is in motion. Some brass finishers' lathes of very neat design, for turning the plugs for, and for forming straight brass cocks, were also exhibited by Messrs. Charles Churchill and Co. The former of these has a neat and simple automatic reversing gear. The second is remarkable for the fact that the whole surface of a shaped cock is attacked at one cut. This is done by a forming tool, which presents in cross section the outline of the cock. The edge of this tool presses against the lower part of the casting, which is very firmly supported, and passes right under it, cutting it exactly to the required shape. In order, however, to avoid the strain which would result from attempting to cut the whole surface at once, the tool is sharply bevelled sideways, so that the cut begins at one end of the cock, and gradually extends to the other. To sharpen the tool only this bevelled end is ground, so that the shape never alters. This forming, by the way, is only one of a series of operations in the manufacture of the cock, which is fashioned complete from the casting in a matter of about three minutes. The other operations are performed by tools fixed in a turret head. Both these excellent machines are by Messrs. Warner and Swasey. A fine Cleveland automatic machine, which was shown at work last year on bicycle parts, was this year making large screws for general engineering purposes.

On Messrs. Charles Churchill and Co.'s stand we noticed also an exceedingly convenient form of stocks and dies, which we are assured have already secured a good deal of popularity. They are called the Oster, and are made in all sizes for all sorts of threads. A set for threading pipes which we examined does not differ greatly in general appearance from other pipe stocks and dies, but has several novel points of importance. The dies and guides are operated by cams, each independent of the other, and are self-containing. The setting device is a fulcrum clamp that is quickly and easily set and released without running back over the finished threads. The dies are very easily removed and can be sharpened on a grindstone. They make a full and finished thread at one cut. A good point is a gauge which regulates the size; by means of this gauge accurate duplicate threads can always be cut.

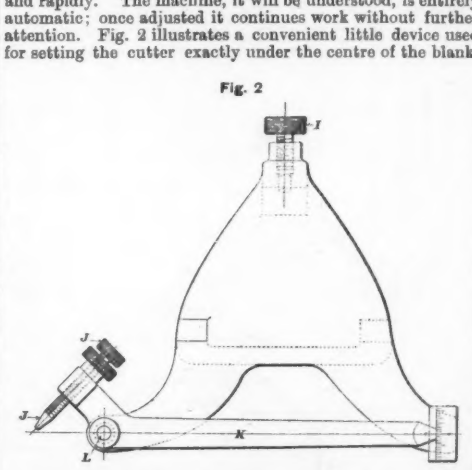
One of the most interesting, if not among the newest, tools at the show was the gear-cutting machine by the Brown and Sharpe Manufacturing Company, which was exhibited at work on Messrs. Buck and Hickman's stand. It is worth, perhaps, devoting a little care to the description of it, although it must be fairly well known to many of our readers. In the first place we may call attention to the manner in which it is usual in America to indicate the size of a spur wheel. In this country we give, as a rule, the circular pitch, obtained by dividing the circumference of the pitch circle by the number of teeth; this frequently leads to small and awkward fractions, and it seems far simpler, and, in the long run, quite as satisfactory, to divide the number of teeth required by the number of inches diameter of the pitch circle, and call the resultant the pitch number. Thus a wheel of 12in. diameter with seventy-two teeth would be said to be of pitch 6, which is for nearly all purposes just as useful, and is far more simply arrived at than multiplying twelve by 3·1416 and then dividing by seventy-two. Messrs. Brown and Sharpe work on the principle that if all makers took up this method and arranged, whenever it was possible, that the number of teeth should divide equally by the number of inches diameter of the pitch circle, it would not only be possible to stock standard wheels of all sizes, just as since Whitworth's time we stock standard bolts and nuts, but that gear cutters could also be supplied of standard shapes in the same manner that stocks and dies are now sold. There can be little question that economy would result. Managers who know the time that is spent and wasted in setting out teeth in drawing-offices will readily appreciate the point. The Brown and Sharpe Company make three sizes of gear-cutting machines and a very great variety of wheels and cutters. The machines are numbered respectively 3, 4, and 5, and it was one of the first type that was exhibited at the Agricultural Hall. It cuts spur gears to 26in. diameter, 8in. face, and 5 diametral pitch. It consists of a deep box bed extended right down to the ground, and forming a cupboard and racks for change wheels. On the top of this there are the two sliding faces, the hinder one higher than the other. It has bevelled edges carefully fitted to the carriage, so that the latter slides without backlash or excessive friction. There is also a long adjusting wedge to take up any wear that may occur. This carriage has, at its left end when facing the machine, a spindle running at right angles to the bed, and well supported at both ends close up to the sides of the cutter, which is keyed to it. The latter is caused to rotate by spiral gearing on a shaft at the back of the machine. The cutting slide, as the carriage is called, is made to move to and from the work by a long screw in the usual way. But the cutting stroke is driven off a shaft which has connection with other parts of the machine, whilst the return motion is driven by an independent belt, and is always performed at the same speed, no matter what the rate of feed may be. The reversing gear, which is entirely enclosed in a box and runs in oil, consists of a clutch positive on one side for the cutting stroke, and frictional on the other side for the return motion. The wheel blank is carried on a spindle which passes through a carriage on a vertical slide on the left of the machine. It is attached to this in the ordinary course by a form of expanding mandril, but arrangements are provided for face-plate attachment when desired. To the back of the spindle is keyed a large worm-wheel with small teeth; a vertical shaft with a small worm drives this wheel, and so "indexes" the blank automatically. The carriage is raised by a vertical screw turned by a hand wheel at the front of the machine, an index on a dial showing exactly how much it has been raised or lowered. The adjustment of the blank for the depth of cut is made by this gear alone. To take up any looseness which wear would in time produce, the worm can be moved towards the wheel so that its thread gears more deeply with the teeth of the latter. The change wheels for driving this worm the right amount to give the correct number of teeth is shown in Fig. 1, in which the vertical shaft on the right-hand side is the shaft carrying the worm.

Fig. 1


SPRING KNOB FOR REGULATING TURNS OF LOCKING DISK
GEAR ON BEVEL GEAR STUD OR LEADING FOLLOWER
SECOND GEAR ON ARM STUD THE LEADING DRIVER
FIRST GEAR ON ARM STUD ON FIRST FOLLOWER
LOCKING DISK-SHAFT OR FIRST DRIVER
LOCKING DISK

The first driver, it will be noticed, is on a spindle, which at its other end carries a locking disc and a spur wheel keyed to it, which is driven from the main shaft through the intermediary of a clutch. This clutch has in connection with it a pair of levers keyed to a little weigh shaft. The end one of these levers drops into an interruption in the locking disc, and holds it fast whilst the cutting stroke is taking place. When the stroke is finished and the tool has returned to position to begin again, the finger is lifted at the same moment that the clutch comes into gear; the shaft then revolves, and through the medium of the change gear gives the necessary turn to the wheel blank. Normally the locking disc makes only one revolution before the finger falls into place again and the clutch is disengaged, but if it is desired, when cutting thin metal or brass, to avoid heating the metal by working too much at one spot, one or more teeth can be skipped to be cut afterwards, the change being made very easily and rapidly. The machine, it will be understood, is entirely automatic; once adjusted it continues work without further attention. Fig. 2 illustrates a convenient little device used for setting the cutter exactly under the centre of the blank.

Fig. 2



It is clamped to the front bed by the thumb screw I; the line K is then correctly on the centre of the machine. The point of the screw J is then brought up against one side of the cutter, and the position of a scratch on the end of the long lever K with regard to the scale noted. The lever is then lifted off the pin L and turned over, so that J bears against the other side of the cutter. If the index then shows the same as before on the opposite side of the zero, the cutter is known to be central. It has been impossible to give anything like a detailed description of this excellent machine, but we trust we have done enough to make its general features clear to those of our readers who are not already acquainted with it.

Messrs. Buck and Hickman also showed a two-spindle automatic screw-making machine by Pratt and Whitney. This is essentially like their automatic machine we described last year, except that there are two sets of cutting tools and tool spindles, one superposed above the other. The rate of turn out is nearly double that of the single machine, whilst the price is not very much greater.

A tube-bending machine, also by Pratt and Whitney, was shown in operation on this stand; it bends bicycle tubes for handle bars and such-like work without heating or filling. The tube is run on to a mandril with an enlarged head, which just fits it, and is bent as it comes off round a grooved wheel. The tube is pulled by a clamp attached at the right place on a long lever worked by two men, which has its fulcrum at the centre of the wheel. The machine is very rapid and handy, and the distortion is not considerable.

A machine which attracted a great deal of attention was shown at work on the stand of Messrs. C. W. Burton, Griffiths, and Co.; it was a large Gisholt turret lathe. It is essentially an engineer's tool, and no stretch of imagination could connect it with bicycle manufacture. It has an hexagonal turret of large size, and is the most powerful machine of its type we have seen at work. It is designed for turning and boring pulleys, spur wheels, bevel wheels, stuffing-boxes, cone wheels, &c., at one setting. All the parts are massive, and precautions have been taken to prevent any dither or shake. A characteristic of the machine is the inclination of the turret away from the operator's side of the machine, so that the long tool carriers necessary for some of the operations may pass during the rotation of the turret clear above the working handles, &c.

A beautiful example of a Landis universal grinder, with micrometer adjustment, was also shown on the same stand.

Messrs. Pfeil and Co. had also a very large exhibit of machine tools, emery grinders, &c., of various sorts, but nothing strikingly novel. Many of their exhibits were really suited to a bicycle show, but we understood from them nevertheless that the business they had done was mainly with general engineers.

Other exhibitors were the Unbreakable Pulley and Mill Gearing Company, Limited, and Messrs. R. Lloyd and Co., of Birmingham, who showed a capital automatic screw machine of small size. It was at work on cheese head steel screws about ¼in. diameter, which it completed from the bar. A notable point was the way in which the little screw after turning and screwing was picked up and held against a small circular saw which cut the slot. It was then dropped into a little cup on the end of a lever, which immediately swung round and upset it into a vessel placed to receive it, clear of all dirt and turnings. The machine was driven by an electric motor at a high speed.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

INSTITUTION OF CIVIL ENGINEERS' ENTRANCE EXAMINATION.

Sir,—Your issue of November 11th contains a letter from Professor FitzGerald, in which he takes up the cudgel in defence of the two questions set at the examination for admission to the Institution, to which "Assoc. Member" objected in a letter published in your issue of November 4th. The first relates to Euler's formula for the strength of columns, the second to a spiral spring. He seems to be of opinion that the objecting examinee ought to have known about Euler's formula, because it is referred to by Bindon Stoney in a work published thirty years ago, but only referred to and quoted. Assuming that Bindon Stoney's book is entitled to be regarded as a text-book, it should contain all the information necessary to enable the applicant for admission to answer all questions suitable for insertion in a test examination paper. Professor FitzGerald, however, states that as the objector has not studied at a technical school, he naturally cannot answer questions about problems which are specially taught, or shall I say with more regard to truth crammed at technical schools. Is not this an admission that, whatever may have been the intention of the Council in establishing these examinations, the examiners they have selected do not look upon them as a means for raising the status of the Institution, but as a means for extending utterly undeserved but sorely needed aid to the technical cramming schools.

Professor FitzGerald states that Euler's formula is based on the assumption that the elasticity is perfect, and that Bindon Stoney has pointed out that the stability of a column depends more on the transverse than the direct compressive strength of the material. Will Professor FitzGerald kindly explain what is meant by the term "elasticity"? Does it mean coefficient of elasticity, or modulus of elasticity? The two interpretations have totally distinct meanings. If the coefficient of elasticity is meant, I cannot conceive how it can be applied to the solution of problems relating to the strength of pillars. If it means modulus of elasticity, then the elasticity will be perfect, so long as the material is not subjected to a stress beyond its elastic limits. Will Professor Fitz Gerald also kindly explain what is meant by the transverse strength of the material; does it mean its capacity to resist shearing? The problem of the strength of columns may be put in two ways: (1) That the working load must not be sufficient to cause a deflection capable of being detected. (2) That in the case of a column with rounded ends, a central deflection is admissible equal to the admissible deflection which would be caused by a central load on the column treated as a horizontal beam resting freely on two supports. The first problem does not admit of a mathematical solution. The working load W must clearly vary directly as the product of the least breadth b of the central section of the column multiplied by its area a, and inversely as its length l, so that we shall have $W = \frac{C\,b\,a}{l}$. In this formula the limiting value of C determined experimentally will correspond with that value of W which first causes a sensible deflection in the column. It cannot be determined from the actual breaking loads of the columns. The second problem admits of a very simple mathematical solution. In the case of the column we need take no account of the weight of the column, because it is insignificant compared with the loads it has to support, except in very special cases; but in the case of a long column treated as a beam, it may be greater than the admissible imposed load. The central load w on a column treated as a beam will therefore be equal to the sum of the imposed load, plus half the weight of the column. If $c\,l$ represents the maximum admissible deflection, the bending moment on the column will be equal to $W\,c\,l$, and on the beam to $\frac{l\,w}{4}$. These must be equal to each other, so that $W = \frac{w}{4\,c}$. If a deflection of $\frac{1}{1000}$th part of the length is admissible, we have $W = 250\,w$. If it is not to exceed $\frac{1}{2000}$th part of its length we have $W = 500\,w$. It will form an interesting exercise for the associate members, who have gained admission by examination, and for technical students to solve a few examples for different sections of columns, and to compare the results with the values of W calculated from the ordinary empirical formulas, with constants determined from the breaking loads ascertained by experiment.

It is necessary to quote the question set about the spiral springs in full. It is as follows:—"A spiral spring supports a weight, whose natural frequency of vibration is n per second. The point of support gets an up-and-down simple harmonic motion of amplitude a, and frequency f. Assuming enough friction to still natura vibration, what is the motion of the weight? What sort of result do we obtain for values $f = 10\,n$, $f = 1{\cdot}1\,n$, $f = 0{\cdot}9\,n$, $= 0{\cdot}1\,n$.

Will Professor FitzGerald explain what is meant by the natural frequency of vibration of a weight or of a spiral spring—if that is what the problem means but does not state? What is meant by the "harmonic" motion of a spiral spring? If the spiral spring were a stretched cord the meaning would be perfectly clear. Pro-

fessor FitzGerald states that the problem admits of easy solution, without having recourse to high mathematics. Will he kindly give that solution in your correspondence columns?

Finally, will he kindly explain what use can be made of the results obtained by a solution of the problem in practical engineering work?

According to "Anglo-Indian," the law of growth of trees in India appears to follow the law of growth of animals. This is different from what occurs in other parts of the world. Elsewhere the height of the tree is increased by successive additions to the top. The explanation of the apparent rise of the height of the B M on the tree, must be sought for by an examination of the level book of the offshoot of the technical school.

November 21st. LAUDATOR TEMPORIS ACTI.

SIR,—Your correspondent "An Outsider," speaks a good deal about students, and, as a student, I should like to draw notice to some of his remarks.

He seems to forget that it is possible for young engineers to join the Institution of Civil Engineers as a "Student," and that anyone of even average intellect could pass the necessary examinations—for "Students." Also I would remind him that a "Student" may pass his Assoc. M.I.C.E. Examination while he is still a student, and thus not be troubled by examinations when he wishes to change his status. This is conveniently arranged, as a man might not be in England at all when he reached the qualifying age of ceasing to be a "Student;" and this fact is, it seems to me, more likely to influence him than any fear of forgetting such fundamental work as that quoted by your first correspondent.

"An Outsider" also mentions expense, but surely any engineering student can afford two guineas a year, and that is all the subscription is, till he is twenty-five. Surely, considering the return in "Volumes of Proceedings," and "Visits to Works," he could scarcely spend his money better.

In conclusion, I should like to remark that the institution of intellectual tests is the only way of freeing our ranks from some very doubtful "engineers." STUDENT.

November 21st.

TESTING CEMENT.

SIR,—Following the German lead, it has been customary in many English specifications to stipulate that the strength of Portland cement be tested after mixture with sand, and it has been held, and rightly held, by recognised authorities that the finest ground cement when so tested give higher results than when tested neat. The use of the sand, however, on account of its varying chemical quality, introduces an element of error, even after the greatest care has been taken in its preparation. There is no necessity for the use of sand in testing, as by the simple expedient of specifying the degree of fineness, coupled with the required tensile strength neat, more reliable results are obtained and therefore better cement secured. It is admitted that the finest ground cement will give higher results when tested with sand, and it therefore follows that all that is necessary to secure a high-class cement is to stipulate for a certain degree of fineness coupled with the usual neat test.

I advocate the following test:—Pats ½in. thick in water, absolutely sound at seven days. Tensile strength, 400 lb. per square inch at seven days, and 450 lb. per square inch at fourteen days. Fineness, 15 per cent. residue on a 100 sieve.

The pats to be gauged on glass, immersed in water immediately, and left there for the whole period. One pat to each three bricks.

The test bricks to be gauged by a skilled man, with a minimum quantity of water, and well rammed into moulds. The average of three to be taken, which shall represent about 100 tons or less. The strain to be applied as quickly as possible.

The sieve to have 10,000 holes per square inch, and to be of wire not less than ·004 of an inch—42 S.W.G.—in diameter. Shaking to be continued for five minutes. V. DE MICHELE.

14, Delahay-street, Westminster.

HIGH-SPEED AIR PUMPS

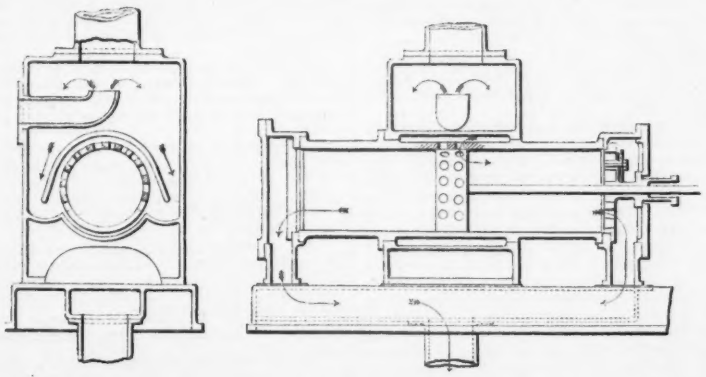
SIR,—In view of the interest which is being shown in your illustrations descriptive of the torpedo boat destroyers for the United States navy, perhaps my experience of an air pump very similar to that shown will not be deemed out of place; especially as its proved efficiency here inclines me to the belief that a few of Mr. Bremner's essentials are non-essentials. The sketches herewith will explain its construction. I have had it on my 270 indicated horse-power engine for three years, running at 90 revolutions.

The valves have been renewed three times only, the last time six months ago—and then not because they were defective—and I have never, even in the hottest part of summer, when, as natives know, water is scarce in Bradford, had less than 25in. steady vacuum. The vacuum is only impaired 1lb. when one valve is off. I can change the valves with the engine running, and yesterday I stopped the engine, replaced the four valves at one end in order to state the time. I found it took eleven minutes, and with a little practice it could be done in less time. There are no foot valves. An examination of the sketch will show that any water which may have once entered the barrel can have very little chance of getting out again except through the eduction valves, the inlet openings being placed in the top part of the barrel so as to allow about double the normal quantity of water to remain in the bottom of the barrel. The makers and patentees are Messrs. Smith Brothers and Eastwood, of this town. Unlike Edwards' or Messrs. Pollit and Wigzell's type—which the latter supply with practically all their engines, as far as I know—the openings are placed in the centre of the length of the barrel, thus allowing more time for the water and vapour to enter, and for the pressure in the barrel and condenser to become equalised—a condition which, as your correspondent Mr. Bremner points out, is necessary in order to obtain the maximum efficiency.

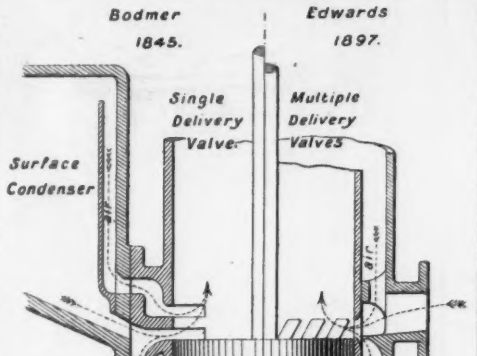
Undoubtedly Edwards' air pump has advantages. Its one great disadvantage is that it is vertical. Its proper place is wherever the vertical form only is admissible, whether by reason of limited length of engine-house or by low water level. There its position as an air pump may, and probably will, be unassailable; but where room for the horizontal form can be allowed it will have to take second place, even if it should prove to be at the expense of a little efficiency, which, however, my experience goes to show need not prove necessary. To apply the vertical necessitates too many moving parts, rocking lever, shaft, links, pedestals, guides, &c., except in the case of the beam engine, to make its presence desirable, especially when to this is added the extra first cost. We all know what a large proportion of engine breakdowns are due to air pumps and their driving connections. To my knowledge the worst form of horizontal has often been put in instead of a comparatively good form of vertical, rather than put up with the coupling nuisances. It appears to me, therefore, that Mr. Eastwood's form of horizontal, which has all the advantages of the Edwards vertical without the drawbacks necessitated by the methods of actuating the latter, only requires to be known to become the only form for land engines at least.

CYRIL WEST LUPTON.

West End Mills, Bradford, November 19th.



SIR,—In view of the correspondence in your paper on the above subject, it is right to point out that so far back as 1845, that prolific inventor, Mr. Bodmer, in a paper read before the Institution of Civil Engineers—"Proceedings," vol. iv.—described and illustrated an air pump practically identical with that lately



patented by Mr. Edwards. I enclose for comparison a sketch giving a half section of each, side by side. Perhaps some of your readers can tell us whether Bodmer's design ever came into practical use. ANTIQUARIAN.

November 28th.

SELF-PROPELLED TRAFFIC.

SIR,—Now that self-propelling traffic is strongly gaining the confidence of the public, it is necessary that the persons responsible for the production of these vehicles should be provided with every facility found requisite according to the dictates of experience.

In November, 1896, the Local Government Board issued regulations with respect to the construction and use of light locomotives on common roads and highways, and notwithstanding at that time the advisers of the Local Government Board had little or no opportunity of obtaining data to enable them to base their conclusions upon, the regulations were by a certain community welcomed with enthusiasm, and they were then considered likely to answer the requirements.

I now, Sir, venture to say that since November, 1896, sufficient practical work has been effected in this special branch of engineering to justify the amendment and reconstruction of certain clauses comprised in the regulations, which as now framed up are in my opinion very prejudicial to the successful promotion of this important industry. My object in writing you is to ventilate the matter, and ascertain the views of the different constructors who are devoting time and capital to the difficult problem of designing self-propelling vehicles suited for heavy traffic on the basis of the regulations as now enacted.

I will proceed to enumerate the prominent clauses to which all persons of experience engaged in designing and constructing heavy vehicles must take exception.

First, the restriction of a light locomotive to the maximum weight of three tons unladen renders the construction of heavy vehicles exceedingly difficult, besides being prejudicial to securing the necessary stability and durability. I refer more especially to steam tractors, on which varying loads from two to four tons are carried, and the result of my experience is fully borne out by the issue of the recent trials held in Liverpool, Birmingham, &c., and where the competitive vehicles were found defective principally owing to the construction being insufficiently heavy. Where a tractor is designed for carrying one or more tons the net weight must obviously be sufficient to obtain the necessary adhesion, so that the vehicle will propel itself upon bad roads and slippery inclines, besides possessing stability and being safe and workable. My experience also tends to prove that an excess of weight beyond the limit given in the regulations will cheapen the prime cost, and ensure greater factors of safety, durability, and stability than can be obtained under the existing restrictions. I assume the regulations were drawn up with a view to reducing the gross weight of a four-wheeled self-propelling vehicle to a reasonable limit for use upon the common highways, the fact of existing horse-drawn vehicles being employed daily with 3in. tires loaded to the extent of six or seven tons being apparently neglected. These limitations upon the self-propelling vehicle are not equitable, there being no restrictions as to width of tire or net weight to regulate the construction of the horse-drawn vehicle to carry from two to eight tons, but such a van would require to be of a net weight, of say, two tons, so that the Act eliminates the use of more than one ton for propelling machinery, which is obviously insufficient.

Secondly, the speed defined for the net weight of the light locomotive I have found in practice to be disproportionate, and prohibitive to the employment of any passenger tractor capable of carrying from twenty to thirty persons, as the speed of five miles an hour is far below the average, and would not only render such a vehicle entirely useless for commercial employment, but would destroy its competitive value as against a horse-drawn vehicle of the same capacity. Doubtless at the time the Act was drawn up the Local Government Board were not in possession of sufficient experience to enable a reasonable limit of speed for weight to be obtained, with the result that the error is on the wrong side, as it is self-evident that a maximum speed of ten miles an hour could be traversed with safety, and answer all commercial requirements.

Thirdly, it is difficult to foresee the object in limiting the extreme width of a self-propelled vehicle to 6ft. 6in., whereas the practice for horse-drawn omnibuses and other wide vehicles varies from 7ft. to 7ft. 6in. The problem of constructing comparatively heavy self-propelling vehicles is not one of easy solution, and this additional restriction is surely an unnecessary obstruction to securing success. The facility and ease with which a well-constructed mechanical vehicle is handled should tend to enlist broader ideas in these matters.

In conclusion, we all appreciate the advent of the Light Locomotives Act in securing the emancipation of self-propelling traffic, but I venture to think that it will be admitted by all experienced in the designing and constructing of light locomotives for comparatively heavy weights that the amendments and modifications set out in this letter on the present regulations will prove highly beneficial to those engaged in the industry.

SIDNEY STRAKER, A.M.I.C.E.

November 16th.

TRANSFERENCE OF HEAT IN COOLED BARS.

SIR,—There are a few remarks I should like, with your permission, to make in connection with your article under the above heading, which appeared in THE ENGINEER for November 11th. In the first place, no one can be more conscious than myself of the incompleteness of the experiments, either of Mr. Stone or myself; and in my first letter to *Nature* I pointed out that the experiments were only made to assure one that one's sense of touch was not playing tricks, and although I mapped out a series of further experiments which would have dealt with most of the points you raise—except, perhaps, the measurement of the total quantity of heat of the system, *i.e.*, water and metal rod—yet, other work pressing, the research had to be abandoned.

You state that "as neither experimenter has recorded the temperature at any part of the bar, it is impossible to say if the heats required for the appearance of recalescence were reached." With the first part of this sentence I agree, but not with the latter portion. In your abstract you note that the effect was observed when the temperature of the hot end of the rod was not high enough to produce the spheroidal state, though not so pronounced as when the temperature was higher. The temperature at which the spheroidal state in the case of water begins is somewhere about 150 deg. Cent., and does not therefore approach the recalescing temperature, viz., 600-800 deg. Cent. This was pointed out in my second letter to *Nature*.

In connection with Mr. Stone's suggestion as to the cause of the effect, and which suggestion has your support, I would like to know by what molecular mechanism the thermal capacity of the cooler end can be lowered, seeing that its temperature may be so low that it can be held in the hand. Does not a higher temperature imply a higher molecular velocity, and therefore an increased amount of energy, or else a very great change in what I might term the chemical aggregation of the atoms or molecules? That the latter should occur at the cooler end is, I think, most improbable. I would rather favour the idea of an actual transference of energy, possibly given out by the contracting envelope of the cooled end to the heated interior portion, and then passed on by some molecular agitation, possibly of wave form, and ultimately reappearing as heat. I quite agree, Sir, that the question is one which merits proper investigation, and may possibly yield results of some interest to engineers. ALBERT T. BARTLETT.

8, Fairfield-road, Old Charlton, London, S.E.,
November 22nd.

THE TRANSMISSION OF HEAT IN BOILERS.

SIR,—In your interesting remarks last week on the subject of "The Transmission of Heat in Boilers," you asserted that "no one" could explain the fact that water flowing over a hot surface absorbed more heat than still water in contact with the surface for the same range of temperature.

Will you kindly allow me space to point out that the explanation is perfectly well known to most people who are interested in the subject? In the latter case, the convection of water to and from the surface—which is the main factor in the transmission—is entirely due to differences of temperature in the water. In the former case, in addition to the translation of the water across the surface, there is, in all cases of turbulent motion, a convection to the surface from all parts of the mass of the flowing water, the amount of which increases as the velocity of flow increases, and which would exist if the water and surface were at the same temperature. The result is that for the same range of temperature the heat absorbed per unit times is found by experiment to be very nearly proportional to the velocity of flow. It is true that this effect of the flow of a fluid over a heated surface was first predicted from theoretical considerations, and afterwards proved by Professor Osborne Reynolds, twenty-five years ago, but it would seem that an appreciation of the fact, and a subsequent discussion of its explanation, has been reserved for later days.

Liverpool, November 29th. T. E. STANTON.

[The facts, as stated by our correspondent, are perfectly well known; they can be found in every text-book. They do not refer to water already uniformly heated to the boiling point, of which alone we were speaking. The received explanation is that the moving water sweeps away bubbles of steam which would otherwise collect on the heating surface, and prevent the access of water. An examination of what takes place in metallic boilers fitted with glass observation plates does not bear out this theory. Hence our statement.—ED. E.]

ELECTRIC LIGHTING ENGINES.

SIR,—The interesting article in your Electrical Engineering Supplement of the 25th instant refers very directly to the Willans engine, and to the company, Willans and Robinson, Limited, over which I have the honour to preside, and as the writer's argument appears to me to be open to some objection, I ask of your courtesy a small space for comment.

His references to the Willans engine are on the whole very complimentary, yet it is plainly suggested that progress lies in the direction of doing away with it, seemingly because, "in the opinion of several engineers," the single-acting engine will not hold its own "for many years longer." Probably no invention, however meritorious or successful, can hope to gain the suffrages of all engineers, and it would be strange if, in a case where so many private interests are concerned, there was not a considerable body of "opinion" against it, not without a tendency to prophesy evil things, as possibly the cheapest mode of getting level with the enemy. It is strange how many evil prophecies the single-acting engine has lived down, and those who wait for the skin of this particular lion may learn from the past that prediction is seldom a

dangerous weapon, except to the prophet. Fortunately there is an opinion of engineers who use engines, as well as of engineers who make them, and so far as the former can be gauged by the orders it gives rise to, those interested in the Willans engine have small cause for discontent. Passing, however, from the opinions of hypothetical persons to certain statements of the writer of the article himself, it may be permitted to me to express surprise at the remark that Willans engines "are sometimes very noisy at light loads," for it is fairly widely known that the Willans engine, at light loads or at any other, cannot run "very noisily," at least for any length of time; if it did so it would break down, for serious noise in it is an indication of something grossly wrong—in fact, of the engine having ceased to be single-acting. That Willans engines — in some special sense, and beyond other engines, must be inferred—"require careful driving and the services of men who are used to them for repairs, as the ordinary engine fitter cannot be trusted with them" is refuted by the experience of very many lighting stations, where the makers' men take no part in the overhauls, and where the smallness of the driving staff is a subject of frequent comment by visitors. The statement, however, to which I desire to take most exception, because it is of general interest, and may mislead makers and users of other engines besides the Willans, is that with ordinary pressures, and condensing, the gain from using triple-expansion "hardly compensates for the extra complication." May I point out that the question of triple or compound is wholly one of steam pressure, or rather of the total range of temperature in the engine? If the steam pressure is high, or the exhaust pressure is low, there should be more stages of expansion, but the better the design of the engine, in the sense of avoiding losses from initial condensation, the greater is the range which a small number of stages can successfully deal with. The Willans engine has drainage facilities shared by no other engine whatever, and its initial condensation, for this and other reasons, is very small. Hence it does not need, so soon as many engines, an increase in the number of the stages of expansion. Non-condensing, there is little advantage in triple-expansion until the pressure reaches 180 lb., but when condensing, with a fairly good vacuum, 140 lb. is sufficient to justify three stages of expansion. Though with other engines the need for an increased number of stages may arise earlier, the principle is the same, and if in any case the makers of the Willans engine put in compounds where others might use triples, it is only because their engine is normally less exposed to the evils which triple expansion is intended to prevent, and the prevention of which has to be paid for, as you justly say, in cost and complication, though possibly to a less extent in the Willans engine than in any other design.

It is said that engines of 1000-horse power are now common, and larger engines are looked forward to, though the writer of the article wisely advises caution. It seems to be thought in some quarters that this rapid increase of size is unfavourable to the Willans engine. Its makers do not think so, and since they have over a dozen engines of 1200-horse power each in hand at the present time, it would seem that their views are shared by those whose opinion, after all, has the most value.

Rugby, November 29th. MARK ROBINSON.

SAFETY MOUNTINGS FOR EMERY WHEELS.

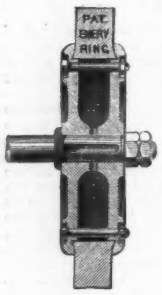
SIR,—With reference to the correspondence which has lately appeared in your paper on this subject, we beg to inform you that for very many years past we have made safety mountings for emery wheels, both for periphery wheels and for face wheels, and quite recently we have taken out a patent, No. 29,104, 1897, for still further improvements in the mountings for face wheels, and in the construction of the same, so that there is no difficulty whatever in securing that emery wheels shall be properly mounted, and run with perfect safety.

We enclose herewith Sheets 4, 8, 9, also patent specification, for your information. LUKE AND SPENCER, LIMITED,
(ROBERT LUKE, Director).

Broadheath, near Manchester,
November 25th.

SIR,—It may be of interest to your readers, many of whom are users of emery wheels, to hear that the wheel illustrated in your issue of November 4th, and again referred to and illustrated in your issue of November 18th, is an exact copy of an improved emery wheel patented in 1877 by Mr. Handyside and Mr. Sterne.

The accompanying engraving, which we published over twenty years ago, illustrates the wheel as shown in both issues as new or relatively new. We have also made segmental wheels forming an entire ring, and these ran for years upon special machines which we made for grinding flat irons. The entire ring clipped by the metal centre consisting of two cast iron discs with edges inclined inwards and shaped to fit the dovetailed parts of the emery ring, has been made by us for the past twenty-four or twenty-five years, and there are thousands of them in daily use upon the well-known tool grinders designed by Mr. Handyside and manufactured by our firm. This safety device for emery wheels has proved both economical and useful in all metal trade workshops. We enclose the patent specification dated January 11th, 1877, No. 137, describing and illustrating the wheel just referred to, also showing the segmental wheel as fitted to the surface grinding machine. L. STERNE AND CO., LIMITED.



London, November 30th. (L. STERNE, Managing Director.)

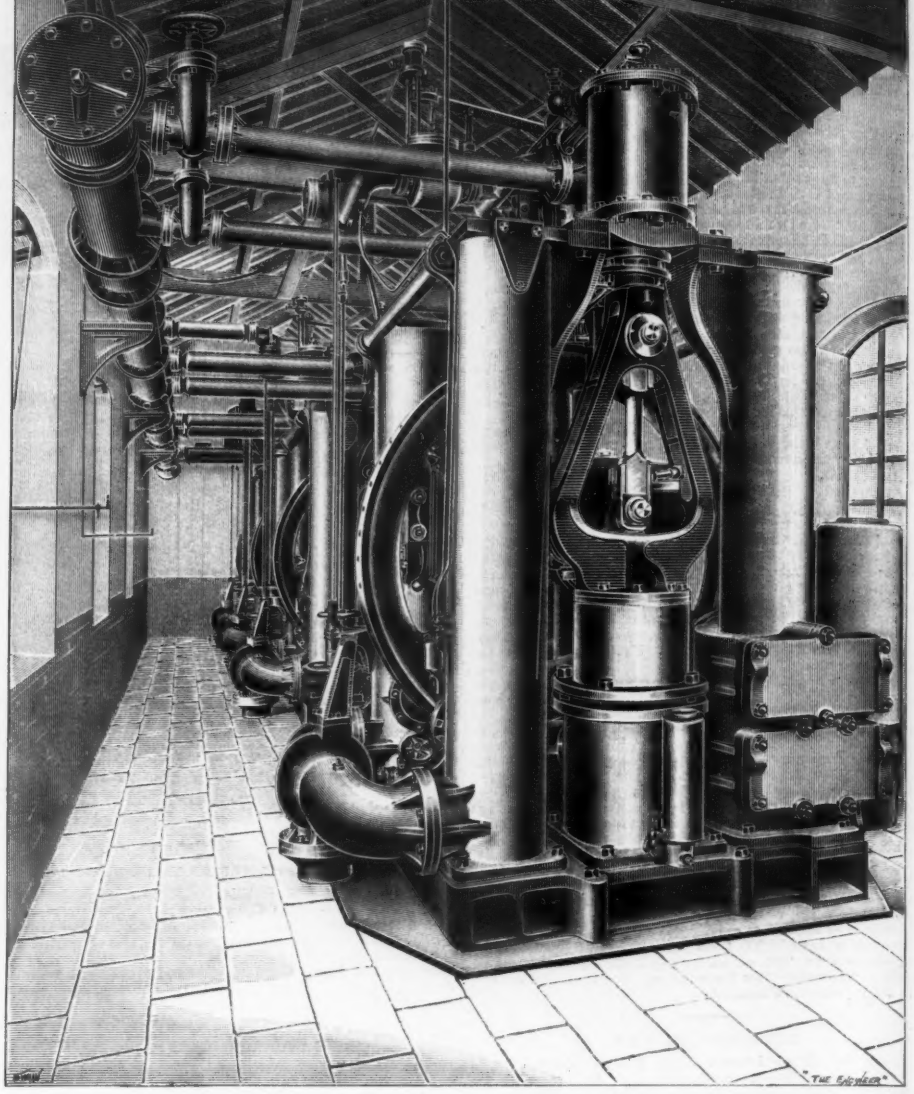
ALMANACS, DIARIES, &c.

WE have received a copy of the *Indian and Eastern Engineer* Diary for 1899. In addition to other useful matter which has appeared in previous issues, the new edition contains a very complete table of metrical equivalents.

RATHMINES AND RATHGAR TOWNSHIP (IRELAND), ELECTRIC LIGHTING.—The Township Commissioners, at their meeting last week, on the recommendation of the consulting engineer, Mr. Robert Hammond, decided to accept the following tenders for the plant for the Township Electricity Works:—Section A, boiler-house plant: Three 30ft. by 80ft. Lancashire boilers and accessories, mechanical stokers, feed pumps, injector, economiser, electric motor, Messrs. R. Taylor and Sons, Marsden, £2924. Section B, engine-house plant: One 300-killowatt and one 150-kilowatt high speed steam dynamos and accessories, motor transformer, spare parts, &c., Messrs. Mather and Platt, Limited, Manchester, £6386. Section D: Ten-ton overhead travelling crane, Messrs. Higginbottom and Mannock, Manchester, £264. Section E: Switchboard and instruments, Mr. James White, Glasgow, £1181. Section F: Accumulators, The Tudor Accumulator Company, Limited, £1958. Section G, underground work: Trenching, cables, &c., British Insulated Wire Company, Limited, Prescot, £14,123. Section J: Meters, Messrs. Ferranti and Co., Limited, Hollinwood, £500.

PUMPING MACHINERY, NORTH-EASTERN STEEL COMPANY

MR. JOHN CAMERON, SALFORD, ENGINEER



PUMPING ENGINES.

THE accompanying illustration represents a large pumping plant supplied by Mr. John Cameron, Oldfield-road Ironworks, Salford, to the North-Eastern Steel Company, Limited, Middlesbrough. There are four pumps erected in the engine-house at present, sufficient space being left for the erection of a fifth pump if required. Each pump has two rams 24½in. diameter, 18in. stroke; the steam cylinders are 19in. diameter, and are fitted with Meyer's expansion valves arranged to cut off steam at various parts of the stroke, this being of considerable advantage in an ironworks where the steam pressure is liable to frequent variation, as the point of cut-off can be easily adjusted to suit the steam pressure. The expansion valves are adjusted by a hand wheel, which is fixed to a vertical shaft supported by a bracket fixed on the columns at a convenient height for a man to adjust the valves from the floor level.

There is an index just above the hand wheel, which shows the point at which the steam is cut off in the cylinders. The expansion valve spindles are both adjusted by the same hand wheel, there being a cross shaft carrying scroll wheels, and an intermediate shaft with bevel wheels communicating with the vertical shaft. The steam stop valve and cylinder drain taps are all worked from the ground level. Each pump is fitted with an equilibrium valve and governor, the governor being worked with bevel wheels from the main shaft of the pump. Each pump has a strong bed-plate of the flange girder section, to which is bolted the columns for supporting the cylinders and crank shaft bearings.

These columns act as delivery air vessels. The ram barrels are bolted to the bed-plate, and are cast separate from the columns; the rams are also made separate and bolted to the triangles. This arrangement facilitates the renewal of the rams when required.

The valves are of india-rubber working on gun-metal grid seats, there being a group of valves on each seat. There are two suction air vessels fitted to each pump. These pumps are used for pumping water for condensing purposes, they draw the water from a reservoir and deliver it into a tank about 40ft. above the ground level, and each pump will discharge about 90,000 gallons per hour, or a total for the four pumps of about 360,000 gallons per hour.

LAUNCHES AND TRIAL TRIPS.

SICILIA; built by, The Fevig Jerskibsbyggeri, of Arendal, Norway; to the order of, The Otho Thoresen Linie; dimensions, 215ft. by 30ft. by 14ft.; engines, triple-expansion, 16½in., 27in., and 44in. by 30in., pressure 170 lb.; built by, Sir Christopher Furness, Westgarth, and Co., Limited; trial trip, November 23rd.

AKER, steel screw steamer; built by, Messrs. Ropner and Son; to the order of, Sir Christopher Furness, for Messrs. Fearnley and Eger, of Christiania; dimensions, 325ft. by 48ft. by 24ft. 3in.; to carry 5000 tons; engines, triple-expansion, 24in., 38in., and 64in. by 42in., pressure 160 lb.; built by, Sir Christopher Furness, Westgarth, and Co., Limited; launch, November 28th.

GREENHILL, steel screw steamer, single deck type; built by, Messrs. Craig, Taylor, and Co.; to the order of, Messrs. W. J. Tillett and Co., Cardiff; dimensions, 278ft. by 40ft. 8in. by 20ft. 6in. moulded; to carry 3000 tons; Engines, triple-expansion, 21in., 34in., and 56in. by 39in., pressure, 160 lb.; built by, Messrs. MacColl and Pollock, Sunderland; launch, November 29th.

SILESIA, steel screw steamer; built by, Messrs. Wi m Richardson and Co.; to the order of, Austrian Lloyd's Steam Navigation Company; dimensions, 400ft. by 49ft.; engines, quadruple-expansion, Yarrow, Schlick, and Tweedie system; launch, November 29th.

PELICAN, twin-screw steamer; built by, Messrs. Fleming and Ferguson, Limited, Paisley; to the order of, the Government of Western Australia; fitted with a Merryweather steam fire engine, for fire-extinction and salvage purposes; speed and towing trials.

LONDESBOROUGH, steel screw steamer; built by, Messrs. William Gray and Co., Limited, to the order of, Messrs. G. R. Sanderson and Co., of Hull; dimensions, 336ft. by 47ft. by 24ft. 10in.; engines, triple-expansion, 24in. and 38in. and 64in. by 42in., pressure 160 lb.; built by, Central Marine Engine Works; trial trip, November 28th.

SYRIA, trader; built by, Messrs. Earle's Shipbuilding and Engineering Company; to the order of, Bennett Steamship Company, Limited; dimensions, 210ft. long; engines, triple-expansion, 19in., 32in., and 52in. by 36in., pressure 180 lb.; trial trip, 14 knots; November 26th.

THE BOROUGH POLYTECHNIC.—Probably no institution of its kind in the metropolis has done more to disseminate technical knowledge than the Borough Polytechnic, which was opened rather more than six years ago in the Borough-road. That it has filled a want is manifest from the growth of the premises. Twice they have required to be extended. The alterations carried out in 1894 involved the expenditure of £4400, and now further enlargements and improvements have been effected at a cost of about £12,000, which does not include the amount required for the furniture and fittings of the various buildings comprised in this second scheme of extension. The new buildings, which are to be formally opened on the 8th of December, consist of a gymnasium, 80ft. by 40ft., four workshops for wheelwrights, boot and shoe makers, printers and bookbinders respectively, a school of cookery, a physics laboratory and lecture theatre, a men's club and refreshment rooms. These extensions have practically enabled the Governing Body to re-model the equipment of the whole of the buildings. Some idea of the growth of the Institute will be gathered from the following figures. Since the opening of the Institute in 1892 there have been 21,589 class entries, whilst last session the students numbered 3080. Towards the cost of the latest extensions the trustees of St. Olave and St. John United Charities contribute £3000. The Central Governing Body have promised £1500, and subscriptions amounting to £2767 have been collected, leaving at present a deficit of about £2000. The premises will include engine, dynamo, and boiler rooms.

THE IMPROVEMENT OF TIDAL CHANNELS BY PUMP DREDGING.[1]

By W. H. WHEELER, M. Inst. C.E., Boston (England).

THE successful application of the system of suction dredging to the removal of sand, the small cost at which the work can be carried on, and the ease with which suction dredgers can be worked in the open sea, and in positions and circumstances which, with the older type of machines, was quite impracticable, has placed at the disposal of engineers facilities for deepening and improving tidal channels in sandy estuaries which did not formerly exist. It is the contention of the writer, and in this contention he is supported by the actual facts:—

(1) That channels in sandy estuaries, if placed in such a direction that the currents of the flood and ebb tide act in harmony, and in which the depth of water is sufficient to resist any surface action due to wind and or other causes, are of a permanent character, and maintain their depth and direction so long as the circumstances under which they were formed remain unaltered.

(2) That in the case of bars at the mouth of tidal rivers the chief cause of shoaling and obstruction is the material drifted along the coast by the action of the tides and wind.[2]

(3) That the regular and continuous movement of this littoral drift does not extend far below the line of low-water mark.[3]

(4) That the action of wind and waves in gales in moving the sand of which the sea bed is composed extends only to a limited depth, and its energy decreases rapidly as the depth increases.

(5) That in a deep channel where there is a large volume of tidal water continuously oscillating backwards and forwards the strength of the current is sufficient to remove any material carried into the channel during a disturbance caused by wave action due to gales of wind.

(6) The numerous permanent channels that are everywhere to be found passing though deposits of sand in shallow tidal seas which have maintained their direction and depth for periods as far back as can be traced, prove that the oscillation of the tidal currents is sufficient to maintain these channels.

If these contentions be right, it follows that, if due consideration be given to the direction of the tidal currents, the entrance channels to tidal rivers or harbours passing through sandy esutaries or obstructed by sand bars, if dredged to a sufficient depth, will maintain themselves without the aid of piers or training walls. The examples hereafter given show that this increased depth can be obtained at a reasonable cost, and at far less expense than by attempting to control the direction and increase the scouring power of the tidal current by piers or training walls. As proof of the fact that channels passing through sand beds retain their permanent character, it is only necessary to point to the channels passing through the great mass of sands overlying the bed of the ocean situated between the South and East coasts of England, and the coasts of France, Belgium, and the Netherlands. The channels used as roadsteads in front of Havre, Calais, Dunkirk, and Ostend, and those on the English Coast near Yarmouth, one of which extends for over twenty miles, and the deeps known as The Wallet, The Sunk, Barrow Deeps, The East Swin, and others too numerous to mention, with depths varying from three to sixteen fathoms, have retained their depth and width without any material change, so far as any records exist.

It is unnecessary to refer to examples of deep channels through sandy estuaries which are known to have retained their permanent character for as long as any record exists, as the author has already dealt with this part of the subject in his paper contributed to the Institution of Civil Engineers on "Littoral Drift."[4] The views here expressed are also confirmed by the surveys and reports made by the engineers of the Belgian Government on the coast from Dunkirk to Flanders, and fully described in M. De Mey's book on "Ports on Sandy Coasts."[5]

A comparison of ancient with modern charts of the coasts of tidal seas where there is a considerable deposit of sand will show that there is little or no movement of sand at a certain depth below low water. Gales that disturb the sand on the bed of the ocean even at a moderate depth occur only occasionally, whereas the scouring action of the tides in the channels which pass through the sand beds is constant and continuous. After the original causes of formation have ceased, and an equilibrium has been set up, the momentum of the volume of water due to tidal action moving in a given direction between two banks of sand is sufficient to overcome any surface action due to winds and waves and to give permanent character to the channels, and will enable them to maintain their original depth, although the sides and bottom are of a mobile character. This even holds good when the channels have a considerable curvature. By deepening a channel a larger volume of tidal water is caused to oscillate backwards and forwards in one given direction on each tide, and being concentrated within a limited width, its action in maintaining the channel is rendered thoroughly effective. The depth of water in the channel necessary for its permanence varies according to the surrounding circumstances; but the minimum depth may be taken generally as from two to three fathoms. The following are successful examples where permanent deep-water channels through sandy estuaries and across sand bars have been secured by means of dredging.

Ship channel through Bay of New York.—The lower bay on the American Coast, through which is the approach to New York, covering an area of thirty square miles, is open to the Atlantic Ocean, the tidal range being 5½ft. Through this bay the main ship channel leads to New York. This channel was obstructed by four long shoals over which the larger class of steamers could only pass at high water. Owing to the vastness of the traffic and the continually-increasing size and draught of the steamers, these shoals were the source of very great inconvenience. A Commission appointed by the Government to investigate as to the means of providing a greater depth of water reported that permanent results could only be obtained by means of training walls four miles in length, extending across the shoals from Coney Island towards Sandy Hook, the estimated cost of this work being £1,250,000. The feasibility of accomplishing the deepening by dredging having, however, been strongly urged on the authorities by Major Gillespie, the Government consented to tentative experiments, and these being deemed successful, dredging was systematically proceeded with. Between the years 1884—90 the channel was deepened by suction dredgers 6½ft., giving a depth of 30ft. at low water. The total cost of this deepening was £258,551. The quantity of material removed was 4,875,079 cubic yards, principally sand, with a large admixture of alluvial matter, which had to be carried 10½ miles to sea. The work was done by contract at an average cost of 26·4 cents per cubic yard (1s. 1¼d). The material had to be raised from a depth varying from 24ft. to 35ft. under water, the total lift being 36ft. to 46ft. The quantity on which the contractor was paid was that in the barges. This was found to be 27 per cent. less than the actual quantity moved, the remainder being carried away by the current. The material having a large proportion of alluvial matter, a considerable percentage went overboard with the water from the hopper, and was carried away in suspension. The plant consisted of three sea-going dredgers varying in length from 132ft. to 157ft., 31ft. to 37ft. beam, and 8ft. to 16ft. in depth, their carrying capacity varying from 275 to 650 cubic yards. Each dredger was provided with two pumps, having suction pipes 15in. to 18in. in diameter, capable of lifting 4200 gallons a minute. In addition to the dredgers there were four large barges and four steam tugs. The dredgers were kept at work in all but the roughest weather, and were not anchored, but were kept continuously steaming ahead while they picked up their load. The lower part of the channel being practically in the Atlantic was very exposed, and the dredgers had frequently to cease working. The average time occupied in filling the largest dredger, carrying 650 cubic yards, was 48·6 minutes; the voyage to and from the dumping ground occupied 1 hour 11 minutes, the time under steam was 16 hours each day, and the quantity moved 6·75 loads, equal to 3936·65 cubic yards. The time lost by repairs, &c., was 2 hours 24 minutes.[6]

The bar of the Mersey.—The entrance channel to the river Mersey lies between two wide sand banks which are dry at low water of spring tides, and which extend out into Liverpool Bay for a distance of about nine miles. The sands at the upper end of the bay, which are uncovered at low water, extend over an area of from 60 to 70 square miles. Where the channel emerges from between the sandbanks it is shoaled by a bar which extends out from the banks into the bay in a crescent form for a distance of 2⅔ miles, and on the crest of which formerly for about one-third of a mile there was a depth of only 11ft. at low water of spring tides. The depth on the lower side immediately outside the bar increased from 5½ to 8 fathoms at the bar lightship two miles below the bar, and beyond this from 8 to 13 fathoms. Above the bar the depth increased from 2½ to 7 fathoms, there being no less depth in the channel up to Liverpool than four fathoms. The range of spring tides on the bar is from 29ft. to 31ft. This bar was a source of great inconvenience to the traffic passing to and from the docks, and especially to the American liners. In the autumn of 1890 the Mersey Docks and Harbour Board decided to have an attempt made to deepen the water over the bar by dredging. As there appeared to be great doubt on the part of those who advised the Board, as to any results obtained being permanent, the works at first were only of a tentative character, two of the steam hopper barges belonging to the Board being fitted up as sand pump dredgers for the purpose. These hoppers were 150ft. in length, and each had a capacity of 500 tons. They were fitted with centrifugal pumps with suction pipes, one 22in. and the other 18in. in diameter, capable of dredging to a depth of 36ft. Under favourable conditions they were able to fill the hoppers in twenty minutes, which time in rough weather was increased to three hours, the average time being one hour. On an average each hopper made five trips a day with a total load of 2000 tons, the maximum quantity reaching 20,000 tons in a week; the distance the material had to be taken being from two to three miles.

At first it was intended that the dredgers should pick up their loads while moving under steam. Experience, however, having shown that there was a liability of the nozzles of the pumps burying themselves in the sand, and, when the sea was at all rough, of injury to the suction pipes, the dredgers were afterwards anchored while taking their load. The proportion of water to sand lifted was about 45 per cent., but under favourable conditions this diminished to 25 per cent. The dredging was carried on continuously for six hours each tide, or from half ebb to half flood, except during heavy gales and storms. It was found possible to work when a fresh breeze was blowing from the most exposed quarter, ranging from W.S.W. to N.E., or, say, up to a force of five on the Beaufort scale. The output varied according to the weather, from 10,360 tons in midwinter to 174,160 tons in the summer, and averaged 4½ loads for each tide. The cost of working, including wages of crew, coal, repairs, and general expenses, but not depreciation or interest on outlay, was 1·38d. per ton, or, say, 2½d. per cubic yard. The material raised at first was coarse sand, but as the depth increased the particles of sand became finer and were mixed with silt. Stones of considerable size and other materials were brought up by the pumps without harm, and in one case an iron buoy sinker weighing 20 lb. passed through the pipes.[7]

The result achieved after working for 34 months up to June, 1893, during 22 months of this time only one dredger being at work, was the removal of 2,438,710 tons of wet sand as measured by the hopper capacity, and a deepening of the channel of from 11ft. to 18ft., a gain of 7ft. over a width 1000ft., and to a less extent over a greater width. Several heavy gales which occurred during this period had no effect in shoaling the deepened channel, and during an interval when dredging was suspended the deepened channel showed a tendency to improve rather than deteriorate.

The Board being satisfied as to the practicability of deepening and maintaining the channel by dredging, determined to provide machinery of greater power and efficiency, and by their order a dredger named the Brancker, designed by Mr. Lyster, the engineer of the Board, was supplied by the Naval Construction Company, of Barrow, and set to work in June, 1893; subsequently a duplicate machine named the Crow was obtained. The cost of each of these vessels was about £65,000. The Brancker is a twin-screw hopper dredger of 2560 tons gross register, 320ft. long, 46ft. 10in. beam, and 20ft. 6in. deep, having a draught when loaded of 16ft. 4in., and being able to steam at the rate of ten knots. The vessel has eight hoppers of a total capacity of 3000 tons, which can be filled in three quarters of an hour. There are two centrifugal pumps having suction and delivery pipes 36in. in diameter. The suction pipes pass down through a well in the centre of the vessel, and are capable of dredging to a depth of 45ft. The pumps are driven by a triple-compound engine having cylinders of 11½in., 18in., and 29in. diameter, with 18in. stroke, steam being supplied at a pressure of 160 lb. The propelling machinery consists of triple-expansion engines. The vessel is fitted with a rudder stem and stern.[8] The cost of the dredging with these machines has been given as 0·81d. per ton, equal to about 1·12d. per cubic yard. From the last report issued by the Mersey Conservator the quantity of material removed up to the end of 1896 was—

	Tons.
By the two dredgers	3,903,090
By the Brancker	9,398,C50
By the Crow	3,862,800
	17,163,940

The depth of the channel was increased to 25ft. at low-water spring tides over a width of 1250ft., with a lesser depth over a greater width. As the depth increased the material to be raised became of a much finer quality and more mixed with clay, so that a much larger proportion passed away with the water which flowed from the hoppers, so that the time for each load increased to 3½ hours. Dredging with the suction dredgers was then suspended and a tugboat, the Alarm, was fitted with powerful pumps and flexible pipes, and a strong jet of water directed on to the bed of the channel, which, acting as an eroder, disturbed the fine sand and silt, which thus being placed in suspension, was transported away by the ebb tide. This vessel is worked four hours each tide. Although there is no means of measuring the actual quantity of material so displaced, the result has proved to be satisfactory. Since this increased depth has been obtained the Conservator of the Mersey reports to the effect that the channel maintains its depth, and that during some very heavy gales from the W.S.W. to W.N.W., which lasted from five to thirty hours, no shoaling was produced; the only effect that could be traced being the levelling of the sand on the bottom.

The Stroombank.—The "Petite Rade," or outer harbour of Ostend, consists of a long narrow channel running through the vast mass of sand banks which cover the bed of the sea all over this part of the ocean. The depth of this channel varies from 4½ to 5½ fathoms, and it is separated from the outer roadstead or main deep-water sea channel which has a depth of five to seven fathoms, by the Stroombank, which runs parallel with the coast, and has a depth of only 10ft. on it at low water. The rise of spring tide is 17ft. This shoal presented great obstacles to the regular running of the steamboats between England and Belgium, and in 1889 the Belgian Government gave instructions for a channel 2000ft. wide to be dredged across the bank, so as to give an increased depth of 6½ft., equal to 16½ft. at low-water spring tides. This dredging had to be carried out in the open sea and across the set of the flood and ebb current. The work was commenced in June, 1890, and the first contract finished in January, 1891, when a depth of 13·76ft. was obtained. A fresh contract was then made, and dredging commenced again in March, 1891, and continued till October, when the required depth of 16½ft. was obtained. The quantity of sand removed under the first contract was 343,000 cubic metres, and under the second contract 339,000 cubic metres. After this one dredger alone was employed in finishing up the work. The total quantity of sand removed was 771,000 cubic metres, equal to 1,008,468 cubic yards. The distance of the deposit ground was 2½ miles. The dredgers were actually engaged in dredging about half the number of working days, the remainder of the time being accounted for by delays from stormy weather and repairs. The dredgers employed were of 220 indicated horse-power, and had a carrrying capacity of about 350 cubic metres, equal to 558 cubic yards. Each dredger under favourable conditions was capable of removing and depositing 3600 cubic metres—4700 cubic yards a day. On an average in summer the dredger made ten journeys, and in winter 6½ journeys. The time occupied on an average in filling the hoppers during the first contract was 50 minutes, and for transport 35 minutes. Owing to the increased depth and the finer character of the sand raised during the second contract the time occupied was longer, the average quantity raised for each hour of effective work in the first case being 272 cubic metres, and in the second 234 cubic metres. The price under the first contract was 0·5835f. per cubic metre, and under the second 0·40f., equal to 5·33d. and 3·66d. per cubic yard respectively.[9] After the work was completed there occurred several violent gales, but the new channel was not affected, and the increased depth was maintained. The results obtained were considered so satisfactory that it has now been determined to dredge a similar channel through the eastern end of the Stroombank for the use of vessels going northwards.

The Charpentier Bar of the Loire.—The approach to the river Loire is through a large area of sand banks which extend out towards the Bay of Biscay from St. Nazaire, which may be said to be the outfall of the river, for five miles, the width where the bar is situated between the two points of the coast being about six miles. The bar extends outwards in a crescent form. The depth of the water seaward gradually shoals from 9 to 4½ fathoms in the course of two miles, and decreased in the main channel on the seaward side of the bar to 3 fathoms, then for half a mile there was, according to soundings made in 1881, a depth at low water of spring tides of 15ft. for half a mile, of 13ft. for a quarter of a mile, of 13½ft. for a mile, and then the depth increased again to 36ft. and 42ft. The principal obstruction to the navigation then extended over 1⅔ mile, the width of the channel being about 1¼ mile. The winds that create the greatest swell on the bar are from the south-west, and in gales the waves attain a height from trough to crest of over 8ft. Spring tides rise from 17ft. to 18ft. over the bar. Although upwards of 400,000 cubic metres of alluvial matter are reported as passing down the river annually, the bar is not formed by the deposit of this material, but is composed of the waste of the neighbouring cliffs. The sand on the crest of the bar consists principally of large grains of quartz; but at a depth of from 3ft. to 4ft. the particles become finer, with a mixture of 30 per cent. of chalk and a small portion of argillaceous matter. The best method of obtaining deeper water was under consideration for several years, dredging being considered impracticable by many of the scientific advisers of the Government; and projects for training the channel, and also for directing the scour of the ebb and flood currents on to the bar by groynes and jetties, were advocated. Finally, after strong representation from the Chamber of Commerce as to the inconvenience and delay caused to the shipping, and an offer to be answerable for the cost of tentative experiments in dredging, the work was declared by the Legislature to be of public utility in March, 1889.

In order not to proceed far until the feasibility of dredging in such an exposed position and the permanency of the depth obtained were ensured, the work in the first instance was limited to the removal of 150,000 cubic metres (196,000 cubic yards). The price fixed was not to exceed 1f. Tenders were invited for the work, and that of Messrs. Volker and Bos, a Dutch firm, was accepted at 15 per cent. below the maximum price allowed, equal to 0·85f. per cubic metre (7·77d. per cubic yard). Two dredgers were employed, and the work was completed in November, 1890, an increased depth of from 0·25 to 0·50 metre (10in. to 18in.) being obtained. The feasibility of the dredging being thus proved, and the increased depth obtained remaining stable during the winter, up to the spring of 1891, a fresh contract was entered into with the same firm to remove 1,000,000 cubic metres (1,308,000 cubic yards) in order to secure a depth of 16½ft. at low water of spring tides over a width of 200 metres (656ft.), twenty-six months being allowed for the work to be done. Previous experience having shown that the work could be done at a less rate than was anticipated, the maximum was fixed at 0·80f. per cubic metre, and the work was taken by the contractors at 20 per cent. below this (equal to 6d. per cubic yard). Work was commenced in February, 1892, and completed in March, 1893—a period of fourteen months.

Four sand pump hopper dredgers were employed, the smallest being 111½ft. long, 25½ft. beam, and drawing when loaded 10ft., with a carrying capacity of 238 cubic metres (311 cubic yards). The largest, 144ft. by 24ft., and drawing 12½ft., with a hopper capacity of 334 cubic metres (437 cubic yards). The distance of the discharging ground was three miles. The night anchorage was two miles from the bar, and the place for coaling and obtaining food and water where the dredgers went from Saturday to Monday was 5½ miles. Out of the total number of days the dredgers were employed 204 were occupied in resting, on 363 days the working was stopped by bad weather and other causes, 113 days were taken up with repairs, leaving 685 days of effective work out of a total of 1363, or about 50 per cent. The average day's work occupied 10·49 hours; 3309 hours were occupied in dredging, and 4496 in transport, the boats making an average 3769 journeys a day. The cost of wages, coal, repairs, and incidental expenses averaged 0·22496f. per cubic metre (about 2·056d. per cubic yard).

On the completion of the contract, pending the delivery of a new dredger built specially for the purpose, one dredger was kept to complete the work and maintain the channel at a contract price of 0·54f. per cubic metre, and from January to June, 1894, removed 146,000 cubic metres. The dredger constructed for the Government and since employed is 161ft. long, 29½ft. beam, and draws loaded 10⅔ft., with a hopper capacity of 435 cubic metres (570 cubic yards). The engines are of 400 indicated horse-power, and the vessel is capable of steaming seven knots, and dredging to a depth of 12·50 metres (41ft.). The pumps can discharge 80·3 cubic metres (105 cubic yards). The cost of this dredger was £14,120. Since the completion of the work in opening out the channel this dredger has been employed in widening the channel and maintaining the depth, the quantity removed in 1894 being 243,779 cubic metres, and in 1895 260,795 cubic metres, taken four miles to the deposit ground. The annual cost of working the dredger amounts to about £2000 a year. The average cost for

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[1] Read at the seventh International Congress on Navigation, Brussels, 1898.

[2] "Bars at the mouth of Tidal Estuaries," Min. Pro. Inst. Civil Engineers, vol. c., 1889—90.

[3] "Littoral Drift in relation to River Outfalls and Harbour Estuaries," Min. Pro. Inst. Civil Engineers, vol. cxxv., 1896.

[4] "Littoral Drift in relation to River Outfalls and Harbour Estuaries," Min. Pro. Inst. Civil Engineers, vol. cxxv., Part III, 1895—6.

[5] "Etude sur l'amélioration et l'entretien des ports en plage de sable." P. De Mey. Paris, 1894.

[6] "Tidal Rivers: their Hydraulics, Improvement, and Navigation," chapters viii., ix., Longmans, Green, and Co., London and New York, 1893. "Improvements of the Channels at the entrance to the Harbour of New York," J. Edwards, Trans. American Society Engineers, 1891.

[7] Paper by A. G. F. Lyster on "Dredging Operations on the Mersey Bar," at International Maritime Congress, London, 1893. Annual reports of the Conservators of the river Mersey, and of the engineer of the Mersey Docks and Harbour Board.

[8] Paper read by A. Blechynden at International Maritime Congress, London, 1893.

[9] *Parts en plage de sable*, De Mey.

coal, labour, and other expenses was 0·197*l.* per cubic metre (1·76d. per cubic yard. The new navigable channel has been well maintained, the depth now varying from 5½ to 6 metres (18ft. to 19½ft.) below low water, a gain of 6ft. over the shoalest part.[11]

Port Natal harbour entrance.—Although the dredging operations that have been carried out at this port do not assume the importance of the other examples quoted, yet they are sufficient to show that a workable navigable depth cannot be secured by scour obtained by the means of guide walls and piers alone, and that sand bars may be removed in the open sea without the protection afforded by piers. The harbour of Natal forms part of a large tidal lagoon on the South-east Coast of Africa, which has been enclosed and protected from the Indian Ocean by a long sandspit known as the Bluff, running nearly parallel with the coast for about two miles. The entrance channel to the harbour is between the Bluff sandspit and another sand bank running out from the shore towards it in a south-easterly direction, leaving an opening about 1000ft. wide. The channel was kept open by the action of the tidal water running in and out of the lagoon, which covers 7½ square miles. In its natural condition the navigable depth did not exceed 6ft. at low water and 12ft. at high water of spring tides over the bar at the mouth, the low water occasionally decreasing after heavy gales to 2ft., the depth beyond the bar in the open sea being from six to eight fathoms, only the smaller class of vessels could therefore obtain access to the harbour. As the town of Durban increased in importance it become necessary to devise means for improving the access to the harbour. With the view of obtaining increased depth a breakwater was run out in continuation of the Bluff sandspit for a distance of 1800ft., and a training wall 1100ft. long constructed on the other side of the channel, the entrance being contracted to 800ft. By this means, aided by a certain amount of sand pump dredging, the depth of water was increased to 14ft. at low water. The depth was liable to be decreased during gales so as to leave only from 5ft. to 7ft., owing to the drift of sand across the opening between the piers and for some distance up the channel.

In 1897 the Government procured from Messrs. Symons and Co., of Renfrew, a second dredger of increased power, called the Octopus. The Octopus, which went out to Africa under her own steam, is a twin-screw vessel of 1300 tons hopper capacity, and provided with two sand pumps having 33in. suction pipes. When this dredger was first set to work in February, 1896, the bar had shoaled and had only 5ft. depth of water over it. The draught of the Octopus light being 18ft., she was at first started pumping and discharging the sand over the side, and in about fifteen hours had cut a passage through the bar sufficient to work in. After this was accomplished the material was taken out to sea, the vessel making from seven to eight journeys a day. In four days a depth of 15ft. was secured over a sufficient width to allow of the passage in one day of nine vessels, the maximum draught being 16ft., the rise of tide on that day being 3ft. 9in. A depth of 17ft. was subsequently obtained and maintained until the autumn, when on two occasions, owing to gales, the depth of the channel shoaled on the bar to 8ft. and 10ft. These shoals were quickly removed by the Octopus, and the depth increased to 18ft. To obtain this the dredging had to be carried out in the open sea without any protection from the piers. Recent reports show that the result of the system of sand pump dredging now systematically carried out has given very satisfactory results, and that a depth of 18ft. is maintained in the channel, allowing vessels drawing 22ft. to navigate it at high water of neap tides. The last reports received from the Colony show that shoaling does not now take place, and that even after gales the channel has maintained its depth, and the bar instead of re-forming, as was formerly the case under similar circumstances, has practically disappeared.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Gasoline power plant.—A number of railways is now putting in gasoline pumping engines at water stations, as they are very economical in operation, and do not require the constant service of an attendant, as a steam pumping plant does. A recent example of this is at La Fox, on the Chicago and North-Western Railway, where are extensive yards for feeding 50,000 sheep and a large number of horses. The animals are taken out of the cars here and fed for a few days to fit them for a good price in the market, or to wait for a rise in prices. The water tanks are supplied by a deep-well pump, which was driven by a vertical steam engine, but recently it was decided to light the yards by electricity, and to drive the pump and dynamo by a Fairbanks single-cylinder gasoline engine of 34-horse power. The engine runs at 180 revolutions per minute. A belt on a 28in. pulley drives a countershaft which is geared to the pump, driving the latter at 35 strokes per minute, the water being pumped at 2280 gallons per minute to a height of 46ft. above the ground. On one of the two fly-wheels is a belt driving a countershaft belted to a dynamo of 12½ kilowatts, operated at 110 volts. The countershaft has a fly-wheel to equalise the speed. This supplies current for five arc lamps and 55 incandescent lamps, the lights being as a rule only used when sheep are being loaded or unloaded at night. The pumping also is done at the same time, as far as possible. When the pump and dynamo are both run at the same time, the speed regulator is such that the pressure on the dynamo varies only 2½ volts under full load. When running at full capacity the engine consumes 20 gallons of gasoline in ten hours, using a cheap grade of oil, costing only 2½d. per gallon. The gasoline is stored in an underground tank holding 300 gallons, from which it is drawn by a small plunger pump driven by an excentric on the engine shaft. The feed to the cylinder is automatic, and any excess feed is returned to the tank. The cost of oil for fuel and lubrication is about one farthing (¼ cent) per horse-power per hour. The entire plant is contained in a building 20ft. by 22ft., and is operated by the man in charge of the yards, no continual attendance being required, but only at stopping and starting, and for occasional inspection.

Distilling ships for the navy.—The naval operations in the recent war with Spain included not only the fitting up of ships for use as transports and troop ships, but also the equipment of ships for special purposes, such as hospital ships, repair ships—or floating repair shops—and distilling ships. Of the latter there were two, the Rainbow and Iris, to furnish water for the troop ships, the small vessels of the auxiliary fleet, and for the troops when landed. Each vessel has twelve cylindrical steel evaporators, 5½ft. diameter and 6½ft. long, filled with 1¼in. straight brass tubes. Each contains about 320 square feet of heating surface. To condense the steam from the evaporators there are four distillers, each fitted with an air pump. They are of the usual design of auxiliary condensers used in the navy, and have each a cooling surface of 300 square feet. There is a 9in. steam connection, 6in. inlet and outlet nozzles, and a 2in. drain opening. The circulating pumps for the distillers are single-cylinder Davidson pumps, forcing the water to the storage tanks. The vessel has a capacity for 400 tons of water in the double bottom, and 300 tons in tanks. The evaporators are fed by three steam pumps, the pipe system enabling any evaporator to be supplied or shut off, while evaporators operated under a vacuum may be fed by gravity. The main steam pipe is 7in. diameter, decreasing in size as branches are taken off to the several evaporators. Three feed heaters are supplied, each containing about 52 square feet of heating surface; there are also two brine pumps, similar to the feed pumps, which carry the brine from the evaporators and discharge it overboard. The evaporators may also be blown out by steam. The evaporators are arranged in sets of three, but are so connected by piping that they may be worked with single, double, or triple effect.

Power gauge for steam engines.—It is rather singular that, in all the improvements in steam engines and their equipment, there has not been included any practical form of gauge showing the actual power developed by the engine at any moment. Indicator diagrams are useful and necessary accessories, but by the time they have been studied and worked out the conditions and power are likely to have varied very considerably. In electrical apparatus we have the watt meter and other instruments which show at a glance the amount of power which is being given out or absorbed by the machines. A gauge is now being introduced in which the pointer shows the indicated horse-power, as a steam gauge shows boiler pressure. Two pipes, like indicator connections, lead from the cylinder ends to the gauge, and the end of each is fitted with two nozzles, so arranged that steam jets from the four nozzles would meet at the top and bottom, forming a diamond or lozenge-shaped outline. These jets impinge upon vanes of a small steam turbine, on the shaft of which is mounted a fan. This fan is in a separate compartment from the turbine, and in the same compartment is another fan, which is driven by the current of air generated by the first fan. Upon the shaft of the second fan is mounted a dead-beat or retarding device, and a retractile spring, while the end of the shaft carries the needle or pointer which travels over the graduated face of the dial. The steam jet from the admission end of the cylinder drives the turbine, and the speed is retarded by the jet from the exhaust end, representing the back pressure, the actual impulse, therefore, being a direct measure of the mean effective pressure in the cylinder. The turbine and its fan revolve at about 1200 or 1500 revolutions per minute, and the rapid whirling current of air tends to drive the indicating fan against the resistance of its spring, thus moving the pointer.

[11] "Le Creusement d'un Chenal à travers la Barre des Charpentiers," par M. De Joly, Annales des Ponts et Chaussées, t. xiii., 1897.

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

THERE is still much discussion going on as to various railway enterprises in South Africa. In the Orange Free State the new policy of railway construction has been inaugurated by the opening of the line to Winburg. In the Cape Colony the Budget for the coming year includes a fairly satisfactory sum for railway extension. In the meantime, a policy of retrenchment is to be adopted in the administration of the existing system. It is said that the present general manager's and chief-traffic manager's departments are to be amalgamated under Mr. Brourger, who is now general manager of the Free State Railways. The maintenance and engineering staffs will be largely reduced; but it is hoped that employment will be found for most of the officials dismissed, in connection with the survey work for the new lines.

Trade in engineering and mining material in Johannesburg is reported to be very dull. This is not so much due to the quietude of demand as to the excessive keenness of competition. Almost every British maker of miners' picks and shovels, lubricants, belting, drill steel, boiler covering, battery screening, and the like, now has an agent on the fields, and the German and American makers of such commodities are becoming more and more generally represented. Then, with at least some of the mines, the practice is growing of buying their stores in England, and importing themselves, instead of going to the local warehouses for supplies. As regards the trade in hand tools—and I may add in lamps, stoves, and many classes of builders' ironmongery—I can entirely corroborate what your correspondent "M.S." says in THE ENGINEER of October 14th respecting American competition. There can be no question that British merchants and manufacturers have a distinct grievance against the British steamship companies who are running steamers at extra cheap freights between the United States and South Africa.

A curious arrangement in connection with municipal engineering has just been arrived at between the Transvaal Government and a Johannesburg capitalist.

The sanitary service of the Golden City is at present about as bad and as costly as it can be, and the Town Council has been talking for years about establishing an adequate system of sewerage. The finances of the Town Council are so involved, however, that it could not even raise a loan for the extension of its electric lighting plant. This difficulty has been met in a manner particularly Transvaalien. In place of advertising for contracts for undertaking the sewerage of the town, the Government at Pretoria has handed over a concession for the sewerage of Johannesburg to Mr. E. Mendelssohn, the proprietor of the local government organ. Practically the only restriction placed upon the concession is that the system adopted must be approved of by the Town Council or the Government, and that the whole system can be expropriated by either of these bodies at the end of twenty years. I believe that the capital for working this scheme will be raised in Europe. As the sewerage system will have as its main object the earning of a profit for the owners of the concession, it is probable that the scheme which can be run at the least expense will have the best chance of adoption.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE declarations of average selling prices in the iron trade form the chief new feature since my last letter. The average for the North of England, showing an advance of 1s. 6d. over the previous return, is regarded as very satisfactory, and although the new not average for the Midlands—namely, £6 1s. 10·68d.—is only a fraction more than a halfpenny over the previous return, yet it means an improvement of 1s. 1·66d. over the corresponding period of last year. The average for this district is still influenced by deliveries under low-priced contracts, entered into before the present revival.

There was a good deal of conversation on Birmingham 'Change to-day—Thursday—concerning the remarkable reports which keep coming to hand about the state of the American steel markets, and especially with respect to steel rails, in which department the American makers seem to be still trying to arrange a satisfactory plan for keeping up prices. It is alleged that values will be almost at once advanced to 19 dols. per ton; that the rail tonnage placed this year in America amounts to 1,950,000 tons; and that next year's demand will be the heaviest on record. Contracts for 50,000 and 70,000 tons are said to have recently been entered into, and during the last three days of last week the sales were estimated to have reached 500,000 tons. Staffordshire steel makers are eating this latest transatlantic dish with a good many of the proverbial grains of salt, but after making ample allowance it appears certain that a good deal of unwonted activity prevails over there, and if similar activity is going to extend to other branches of the American iron and steel trades, competition with this country may perhaps tone down a little. Meanwhile our steel works in Staffordshire and the Midlands keep very busy. Basic steel of local make is quoted £7 to £7 2s. 6d. for bars, £7 to £7 5s. for plates, £6 10s. for angles, and £6 5s. for girders. A considerable quantity of Welsh and North of England steel is coming to hand, and agents for this outside metal offer Bessemer blooms and billets at £5 to £5 5s., and best Siemens ditto £5 5s. to £5 10s.

Smaller stocks of pig iron at the Staffordshire furnaces than producers have been accustomed to for several years past, combined with limited current make and a large demand, are the factors which at the present time are keeping up the values. In some departments of the pig iron trade better prices are, indeed, being secured than during the past decade. Cinder forge was quoted this afternoon 45s. to 46s.; part-mine, 48s. to 50s.; ordinary hot-air all-mine, 65s. to 67s. 6d.; best ditto, 66s. to 69s. 6d.; and cold blast, 92s. There appears to be no movement among producers to put more furnaces under blast, their policy being to keep up prices as long as possible at their present level by making the material comparatively scarce. Nor can it be wondered at that this is the line they are taking since the experience of the past few years affords them a very good argument in favour of recuperating themselves during the present revival as some set-off to previous bad times. Northampton forge is 49s. to 50s.; and North Staffordshire, Derbyshire, Leicestershire, and Nottinghamshire, are about 50s. to 52s.

Better prices in the New Year are looked forward to by the marked-bar firms as a result of the higher prices of pig iron and the recent advances in fuel. The advance in the basic price of marked bars at the last quarterly meetings from £7 10s. to the present price of £8 is described by some of the list houses as being quite inadequate to cover producers for the increases in coal and pig iron; and heavy contracts are not even now deemed acceptable without some little advance on the £8 minimum. Second-grade iron made by the marked-bar firms is still quoted 10s. below their best. Firms who go in largely for an ordinary unmarked-bar trade are asking £6 7s. 6d. to £6 15s., and are full of work to the end of the year, whilst merchants' iron moves freely at about £6 15s. to £7.

Nut and hurdle iron is quoted £6 5s. to £6 10s., and rivet iron £8 10s. There is a slightly better demand for nail rods than recently, but the local demand for this class of material is by no means as large as it used to be, owing to the falling off in the demand for locally-made nails, in consequence of German and American competition. On this last point it is noteworthy that the exportation of wire nails from the United States has grown from 1½ million pounds weight in the year 1888 to nearly 23 million pounds weight in 1898. At the former date the average value of the wire nails exported by the States was 10 cents per pound, but in 1898 it was only 2 cents. It was not until near the end of the first quarter of the present century that any considerable quantity of nails was made in the States with nail-cutting machinery, and not until 18·3 that Bessemer steel was used for cut nails. Wire nails began to make their appearance in 1882, and by 1883 were being substituted for cut nails—a process which is still in progress with ever-increasing success.

Galvanised corrugated sheets this afternoon realised £11 to £11 10s. f.o.b. Liverpool. Plain black sheets were £6 15s. to £6 17s. 6d. for singles, £7 to £7 5s. for doubles, and £7 15s. to £8 for trebles. Hoops are £6 15s. to £7, and gas strip is £6 to £6 2s. 6d.

The excitement in the copper market to which reference was made last week has somewhat abated, and rather less disposition to do business is manifested, quotations averaging 56⅜ to 56½, cash; and 56½ to 56⅝ three months.

The strike in the tube-fittings trade has terminated by the employers conceding an advance of 2½ per cent. as from October 1st until March 31st next, and then a further 2½ per cent. advance from April 1st to the end of next December.

Lord and Lady Dudley will be asked to be present at the ceremony of breaking ground for the sinking of the new colliery shaft at Baggeridge Wood alluded to in a recent issue. A syndicate is also conducting borings on the estate of Major Francis Monckton, in the neighbourhood of Penkridge. So far, a depth of 2000ft. has been reached, and the strata passed through is similar to that which overlies the carboniferous measures of Cannock Chase. The output of the South Staffordshire coalfield seems, therefore, likely to be considerably increased at an early date, and colliery plant to be in proportionately augmented demand.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Although, so far as makers and manufacturers are concerned, there is no indication of any weakening whatever, but if anything, rather a tendency towards a still further hardening in prices for both pig and finished iron, the position of the market is to some extent just now one of waiting upon events. In some quarters the impression prevails that prices have for the present at least got to the top, and merchants here and there are underselling, whilst consumers who have iron bought to cover current requirements are in many cases holding back from placing further orders pending possible developments. That prices are at all likely to be lower, at least for some time to come, is, however, very questionable, in view of the present general activity throughout all iron-using branches of industry; and with the books of both pig and finished iron makers well filled into next year, it is altogether improbable that for the next few months they would be at all disposed to entertain business at anything under their present full rates. One consideration which probably weighs to some extent with consumers is the fact that America has until quite recently supplied large quantities of pig iron at prices that have competed with English brands, and which have tended to check any very material upward move in the markets here. Whether similar conditions will prevail in the immediate future would, however, seem to be somewhat doubtful. For American pig iron considerably higher prices than those which have previously been ruling are now being quoted, and the question is whether the prices to which English makers may put up their quotations will be sufficient inducement to bring over large quantities of iron from the United States. With regard to the engineering trades, no specially new feature can be reported. Here and there some of the smaller works, or establishments that are perhaps not quite up to date, report a falling off in new orders coming forward to replace those running out. But taking the engineering industries all through, activity is well maintained; and as regards the leading machine toolmakers, boilermakers, stationary and locomotive engine builders, hydraulic and electrical engineers, they are mostly assured of full employment over the ensuing year.

Business in the iron market here has not been quite so brisk during the past week, but there was a full attendance at the Manchester 'Change meeting on Tuesday, with a very fair weight of buying going on. For pig iron there are still considerable inquiries on the market, and although buyers rather hesitate about placing orders at the top prices now ruling, makers hold to their full rates, with here and there higher prices quoted on foundry qualities. Lancashire makers have further advanced their rates for foundry, and are now asking 53s. 6d., less 2½. Lincolnshire makers are all holding for prices above the list basis, No. 3 foundry not being obtainable under 52s. to 52s. 6d., whilst Derbyshire brands are stronger, and quoted about 54s. to 55s. net, delivered Manchester. The recent advance in forge qualities is checking inquiries from finished iron manufacturers, who are expecting to buy American iron on more favourable terms than local and district makers are asking. Delivered Warrington, however, local makers are not disposed to sell under about 49s. 6d. to 50s., less 2½, and Lincolnshire about 49s. to 49s. 6d. net. With regard to Middlesbrough iron, the special prices that were being quoted a week or so back have disappeared with the collapse in warrants, and good foundry brands might be bought at 54s. 4d. to 55s. 4d. net, according to delivery by rail Manchester. Scotch iron is stronger, and, delivered Manchester docks, Glengarnock is quoted 55s., and Eglinton 55s. 6d., with American pig iron averaging about 50s. to 52s. 6d. net cash.

In the finished iron trade no great weight of new business is being booked, but as makers are well sold into next year, they are quite indifferent, and Lancashire bars are firm at £6 10s., with £6 12s. 6d. got in some cases for prompt delivery, whilst North Staffordshire bars are not now quoted under £6 15s.; sheets remain at £7 5s., and hoops, although only quiet, are steady at the association rates of £7 for random, to £7 5s. for special cut lengths delivered Manchester district, and 2s. 6d. less for shipment. The best rates of nut and bolt makers are nominally unchanged, but advances on these are quoted for new business.

For both raw and manufactured steel a continued active inquiry

is reported, with a further hardening in some directions. Ordinary foundry hematites are not quoted under 65s. 6d. to 66s. 6d., less 2½; billets are now firm at £4 15s. net cash; bars range from £7 to £7 5s.; common plates, £7 2s. 6d. to £7 7s. 6d., and boiler plates, £8 2s. 6d. to £8 5s., delivered in this district.

The federated engineers throughout Lancashire will receive with very general regret the announcement of the death of Mr. John W. Whittaker, who for the last five years has filled the position of organising delegate of the Amalgamated Society of Engineers in this district. During the protracted strike, Mr. Whittaker was a prominent figure as the official representative of the workmen, and although never losing sight of their interests he endeavoured to conduct his dealings with the employers in a conciliatory rather than an aggressive spirit. This invariable straightforwardness in all transactions won for him the respect of the federated employers, which perhaps is not exactly to the liking of many of the more bellicose trade unionists, and Mr. Whittaker, in some quarters, was subjected to a good deal of undeserved censure. I may add that prior to his appointment to the office of organising delegate Mr. Whittaker had acted for several years as vacant-book officer at the Manchester headquarters of the society, and had previously held various posts in connection with the organisation. He also took an active part in the co-operative movement in Leeds, and was one of the original promoters and a director of the Keighley Ironworks Society—an industrial enterprise based on the co-operative principle. At the joint conferences between the employers and the workmen, which were held with a view of bringing the recent engineering dispute to a close, Mr. Whittaker was one of the workmen's representatives.

A continued steady improvement is noticeable throughout the coal trade of this district. For all descriptions of fuel an increasingly active demand comes forward, and in the lower sorts there is a strong upward move on late rates. Not only are pits being kept on full time, but collieries are commencing to fill up out of stocks to meet customers' requirements. The better qualities of round coal are now moving away readily for house-fire purposes, and as stocks of these are not all heavy, prices are exceedingly strong, with a hardening in isolated cases; but there is not as yet any actual advance on the list rates ruling last month. The lower class round coals are meeting with an enlarged demand for ironmaking, steam, and general manufacturing requirements, with prices stiffening, but general quotations remain at about 7s. 9d. to 8s. 3d. for good ordinary steam and forge coals at the pit mouth. There is a decided pressure for supplies of all descriptions of engine fuel, and both merchants and consumers are experiencing considerable difficulty in covering their requirements. Many of the large collieries are already oversold for their output, and it is exceptional where stocks of any great weight are held. Prices, which have been steadily hardening for the last week or two, are now being generally advanced to the extent of 5d. per ton in the Manchester, and 3d. per ton in the Wigan district upon the November rates, representing an upward move of 9d. to 10d. per ton upon the prices that were ruling this time last year. Common slack is now quoted 3s. 9d. to 4s., medium 4s. 6d. to 4s. 9d., and best qualities 5s. to 5s. 6d. per ton at the pit mouth.

A moderate shipping business is being put through, with no alteration in the average selling prices, which are about 9s. to 9s. 3d. for ordinary steam coal, delivered at the Mersey ports or the Manchester Ship Canal.

Barrow.—There is a very firm tone in the hematite pig iron trade, and the excitement in the market last week has given way to a more reasonable condition of things. No less than 11,113 tons of iron were rushed into stores last week, and thus enabled the "bears" to depress prices, which reached 59s. and are now quoted at 57s. 7½d. net cash sellers, 57s. 7d. buyers. Stocks in hand now stand at 135,313 tons, being 49,137 tons less than in January of the present year. There is still a very full demand for hematite in the open market, and makers have their hands more than filled in the work they have in hand already. There are forty furnaces in blast, as compared with forty-one in the corresponding period of last year, when the demand was not so full nor so pressing as it is now, and when stocks were very much greater.

Iron ore finds a very steady and brisk market, and raisers are not yet able to raise sufficient additional metal to justify smelters putting additional furnaces in blast. Prices are very firm and steady, good average sorts being quoted at 14s. per ton net at mines, while common sorts are at 11s., and best descriptions at 17s. 6d. Spanish ores are selling at about 17s. 6d. delivered at West Coast ports.

In the steel trade business is very brisk, and orders are fully held. The demand for heavy steel rails is steady, and the threatened American competition has not yet been felt. Heavy sections are still quoted at £4 12s. 6d. per ton, and the orders offering represent large consignments for the home and colonial railways for delivery during next year. There is a growing inquiry for ship plates and other descriptions of shipbuilding material. Makers are very fully sold forward, and have in hand very full orders. Prices are steady at £4 15s. per ton for heavy plates, with angles at £4 10s. A very brisk trade is being done in hoops, tin bars, billets, merchant steel, and cast steel.

There is nothing new to report in shipbuilding and marine engineering circles, except the continued extensions that are being made in the various departments of Vickers, Sons, and Maxim's Naval Construction Works, with the view of enabling them to deal with a greater volume of work. Some new departments are being added to the already large number, so that more and more of the work incidental to the building of ships will be undertaken at these works. The first-class cruiser Amphitrite will soon be ready for delivery to the Admiralty, and the Clan Ferguson, turret-decked steamer for the Clan Line, is almost ready for sea.

The coal and coke trades are very briskly employed, and prices remain firm.

Shipping is busy at West Coast ports. The exports of pig iron during last week reached 13,801 tons, and of steel 5933 tons, as compared with 13,695 tons of pig iron and 15,817 tons of steel in the corresponding week of last year, showing an increase of 106 tons of pig iron and a decrease of 9833 tons of steel. The total shipments this year have reached 483,052 tons of pig iron, and 474,745 tons of steel, as compared with 404,882 tons of pig iron and 430,366 tons of steel in the corresponding period of last year, showing an increase of 78,170 tons of pig iron and 44,379 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

INCREASING confidence is felt in the Yorkshire coalfield as to the business outlook. Business is going on quietly, a steady demand being regularly met by the output and values trending upwards. Although the tonnage which is being raised is large, it is not too large for the market, and thus stocks at the different collieries do not get heavy. In house coal, the change in the weather to rather more seasonable conditions begins to influence trade. Buyers are more disposed to do business, and householders, after the touch of winter they have recently experienced, are completing their supplies to tide them over the cold weather. London is taking quite an average tonnage, and the other markets are up to former seasons, and, in fact, a little better. In household sorts best Silkstones are easily saleable at 9s. to 9s. 6d. per ton; ordinary, from 7s. 6d. per ton; Barnsley house, 8s. to 9s. per ton; seconds, from 7s. per ton. In steam coal, the requirements of the railway companies are even larger than they were at this time last year, and in some instances beyond the quantities contracted for. Business is further assisted by the briskness in the iron trade and the prolongation of the export trade, the Baltic ports having kept open for a period considerably in excess of the average. In steam coal Barnsley hards make from 8s. to 8s. 6d. per ton; seconds from 7s. per ton. It is confidently expected that an advance will be obtained on these prices both on railway and shipping contracts at the beginning of next year. This is now the season for gas coal being at its briskest, and the gas-coal pits are all fully occupied, 8s. to 9s. per ton being readily obtainable all over. In engine fuel prices are going up, more particularly for smaller sorts, which are in demand for coking purposes. Good nuts make 6s. 6d. to 7s. 6d. per ton; screened slack, from 5s. to 5s. 6d. per ton; pit slack, from 3s. 6d. per ton. Best washed coke is in brisk demand for Derbyshire, North Lincolnshire, and Northamptonshire, at from 12s. to 13s. per ton—these figures showing 6d. per ton advance; ordinary, 11s. to 11s. 6d. per ton.

In the heavy industries of the city the one report all round is "continued briskness." There is scarcely a branch of these trades which is not fully employed, and in a few instances the difficulty of manufacturers is to complete their orders within a time satisfactory to their customers. Iron and steel, through the abnormal activity, are fetching more money, and the contracts now being placed for finished materials are necessarily at higher figures. All our firms engaged in the production of marine forgings and castings are exceptionally busy, owing to the activity of the various shipbuilding yards. Tires, axles, springs, rails, fish-plates, buffers, and every description of railway material, wagons, and rolling stock generally are being turned out in great quantities, and nearly every department of Sheffield machinery is being run for all it is worth, and even then the orders put forward more than make up for the work turned out. Hematite irons are as formerly quoted. Iron bars, as the result of dearer pig iron, somewhat higher wages to puddlers, and other causes, have advanced 5s., making the price £6 15s. per ton. Steel billets are at £6 per ton. Great activity is being shown in extending the machinery for producing armoured plates, and a very large sum is being expended on that account by all the three local firms who make a speciality of that important feature of military material.

The death is announced of Mr. William E. Wells, managing-director of Messrs. J. and G. Wells, Limited, Eckington Collieries, near Sheffield. Mr. Wells, who has been in indifferent health for some time, was believed to have recovered, and had recently attended to business; but he subsequently had a relapse, and a fatal termination of his illness took place on the 29th ult., at his residence, Elmwood, Moseborough. Deceased, who was the eldest son of the late Mr. George Wells, one of the founders of these extensive collieries, was only 47 years of age. He was much respected in the district.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE "rig" in Cleveland warrants, which for two months has seriously affected legitimate trade in Cleveland pig iron in this district, has at last been brought to an end. It has continued much longer than anyone could have predicted, but after having lasted so long the end came somewhat unexpectedly, though it is none the less welcome, as it has been heartily wished for. Unfortunately it has continued so long that the time is past for expecting any briskness in pig iron for some months to come; the autumn trade has been practically paralysed, and there is now the winter ahead, so that there can hardly be any appreciable activity until the spring. Towards the close of last week the "bears" became convinced of the futility of endeavouring to overcome the holders of warrants, it being abundantly clear that the position of the latter was too strong, and that the longer the settlement of the struggle was deferred the harder would be the terms exacted. Wherever No. 3 Cleveland pig iron was obtainable, either from makers or second hands, it was bought up and made into warrants, but the quantity so secured was far from enabling the "bears" to meet their engagements—they had sold Cleveland warrants, and must deliver them or pay the differences. It therefore became incumbent on them to come to terms with the "bulls," at any rate as far as regarded their commitments for November. In the "squaring off" the "bears" have undoubtedly been heavy losers, for the terms are variously stated to range between 52s. and 55s., which is far above the figures at which they had sold. When the "rig" commenced in October, Cleveland warrants were at 43s. 6d.; they went up 4s. in that month, and 4s. 6d. more in October, and at the close of the "gamble" buyers were offering 52s., with sellers asking 54s. It is not likely that the "rig" will be resumed this month, though some of the "bears" are committed to the delivery of heavy quantities of Cleveland warrants. Some traders think that the "bear" party may start a similar "rig" in other warrants in order to make up for the losses they have sustained in their operations in Cleveland iron.

Legitimate trade in Cleveland pig iron is recovering, but only slowly, and it will be some time before there is a regular return of confidence, for the continuance of the "rig" has landed the trade in the middle of the dull season. A good deal of business has been entirely lost through the action of speculators lately, and what should have been the briskest season of the year has been a very poor one, because consumers abroad and in other home districts could not afford to pay the high prices that were demanded for No. 3, and which speculators would pay, and they therefore had to purchase iron elsewhere, as they could not wait till normal circumstances again prevailed. Owing chiefly to the "rig" the shipments of Cleveland pig iron for November only reached 80,554 tons, whereas in the corresponding month last year they were 106,522 tons, and in November, 1896, over 124,000 tons. The November exports, in fact, this year were the smallest that have been reported in the eleventh month of the year for some years, the decrease being chiefly to the Continent. Local consumers have been frequently forced to use other qualities than No. 3, and there are cases where founders who had bought No. 3 had No. 1 sent to them, the same price being paid as had been agreed upon for No. 3.

Naturally the stock of Cleveland pig iron in Connal's warrant stores was very largely increased in November. In October the increase was 4037 tons, but in November it was no less than 30,691 tons, the quantity reported at November 30th being 123,744 tons. Thus a very considerable proportion of the No. 3 made must have been sent into the public stores. As there is not now the necessity for making warrants that there was last month, it is probable that the storing will shortly cease.

The price of No. 3 Cleveland G.M.B. pig iron has settled down at about 45s. per ton for prompt delivery, a figure very different from those that were asked and paid last week. It is generally believed that makers will be able to keep it at 46s., and that this year, at least, it will not decline to the rates that ruled just prior to the commencement of the "squeeze." Consumers are not yet prepared to buy for forward delivery, but they are inquiring freely for iron for early delivery; they are very short of No. 3, as they have bought so little of late. There is also a dearth of this quality with makers, so that there is not a likelihood of the price going down much. No. 1 is 47s.; No. 4 foundry, 44s. 6d.; and grey forge 43s. Forge qualities have not been influenced by the close of the "rig," but they are still relatively cheaper than No. 3.

Business in East Coast hematite pig iron is improving, and being unaffected by the recent gamble in warrants the gain in prices has been brought about by legitimate trading, and is fully maintained. About 55s. 6d is asked for mixed numbers. Rubio ore is at 14s. 6d. for next quarter's delivery here, or 14s. 9d. prompt. The stock of hematite in Connal's stores at the end of November was 36,648 tons, a decrease for the month of 3379 tons.

The manufactured iron and steel industries continues very prosperous; in fact, never have they been so active, and producers find it almost impossible to get the work out quickly enough to satisfy consumers. There is an extraordinary briskness in the home demand, and at present manufacturers take little account of foreign competition. The plate trade is the most prosperous, and this is due to the unprecedented activity in the shipbuilding and engineering industries. The prospects are altogether encouraging, as these industries promise to have as good a time in 1899 as they have had this year. The tonnage of shipping built this year exceeds that of any previous year. Steel ship plates have been raised to £6 15s., and boiler plates to £7 5s., less 2½ per cent. Other prices are the same as those of last week.

The North-Eastern Railway Company has purchased the sites of the West Stockton and Westbourne Ironworks, which are in close proximity to their Stockton Station, and will lay down sidings thereon when the works are dismantled, as they will shortly be. The company is also acquiring additional land for sidings near Newport, in order to enable them to cope with the large increase in local traffic. On the site of the old Erimus Iron and Steel Works, the Middlesbrough owners will place their timber yard, the site of their present yard, near Cargo Fleet, being required by the railway company for the extension of Middlesbrough docks.

The directors of Messrs. Dorman, Long, and Co., Limited, Britannia and West Marsh Iron and Steel Works, Middlesbrough, are about to acquire the sheet manufactory of Messrs. A. P. Dorman and Co., Ayrton Rolling Mills, Middlesbrough, and will lease, with option of purchase, the iron and steel wire mills of Messrs. Charles Dorman and Co., Bedson Wire Mills, Middlesbrough.

Mr. Alfred Berkley has been appointed works manager of the Fownes Forge and Engineering Company, of Tyne Dock. Mr. Berkley is a son of Mr. Phillip Berkley, who was long connected with Palmer's Shipbuilding and Iron Company, with which concern Mr. Alfred Berkley has also been associated. Mr. Arthur A. Fownes, brother of Mr. Henry Fownes, the managing director of the company, will take charge of the commercial department of the company, and the works will shortly be opened.

The official statistics compiled by Mr. Waterhouse for the Board of Conciliation show that in September and October the average realised price for manufactured iron in the North of England was £5 6s. 5·25d., this being 1s. 6·17d. per ton more than in the previous two months. Wages at the mills and forges for December and January will continue the same as in September and October; as to justify an advance £5 7s. 6d. will have to be reached, whereas for a reduction £5 2s. 6d. will have to be reported. Rails showed a decrease in price of 3d. per ton, as compared with July and August, but plates rose 2s. 4½d., bars 4d., and angles 1s. 5d. The production showed an increase of 874 tons, a large increase being reported in bars, but a decrease of 10 per cent. in plates was recorded.

The new bridge which the North-Eastern Railway Company propose to erect over the Tyne to relieve the traffic over the High Level Bridge, and for which they are applying to Parliament for powers, will be entirely a railway bridge, no provision being made for foot passengers or carriages. It will be situate 750ft. to the east of the Redheugh Bridge, and will be wide enough for four sets of rails. It will cross the river in two spans, each of 300ft., and there will be one central supporting column of granite. Straight lattice-work steel girders will be used, and there will be five, each lying parallel with each other. These girders will be 27ft. deep, and each will weigh 300 tons. The distance from high-water mark to the bottom of the girders will be 83ft. The estimated cost of the bridge, with the approaching viaducts, is about £500,000.

The coal trade is generally satisfactory, though the bad weather at sea has greatly interfered with the shipments, and in consequence there has been short time at some of the collieries. Steam coal is stronger in price, so far as regards best qualities, 9s. 6d. to 9s. 9d. per ton f.o.b. being quoted. Small steam coals are in better supply than demand, and 5s. will be accepted for them. Best gas coals are at 8s. 6d. to 9s. per ton f.o.b., and locomotive coal 9s. 6d. at the pit, the latter being, it is believed, the quotation that has been sent in to the North-Eastern Railway Company for their next half-year's supply. Blast furnace coke is on the average realising 15s. 6d. per ton, delivered at Middlesbrough furnaces over next half year. One of the leading North-country firms of coalowners is disposing of their collieries, and have, it is reported, already sold two of their Northumberland pits to a Tyneside syndicate. Durham University have decided to confer the honorary degree of M.A. upon Sir Lindsay Wood, Bart., Chester-le-Street, the Chairman of the Durham Coal Trade Association.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE Glasgow pig iron market has been unsettled, although a large business has been done in Scotch and Cumberland warrants. Scotch warrants have sold from 49s. 3½d. to 50s. 0½d., and down again to 49s. 7½d. cash, and at 49s. 6d. to 50s. 3½d., and back to 49s. 11½d. one month. There has been a good deal of speculative business in Scotch iron, which is believed to furnish the great market at the moment, although there appears to be some difference of opinion as to how long this state of matters may last. The market for Cleveland warrants has been all but destroyed for the time by the "corner" in warrants of that iron. The general opinion on 'Change is that a settlement has been made by the parties who were some time ago caught short of Cleveland warrants. Now that the "bulls" have had their way, it is not at all quite plain that they will find immediate buyers for the stock they have got into their possession. The condition of trade is, no doubt, greatly in their favour, but speculators have been frightened away from the market. There has, therefore, been no public business in Cleveland warrants, the nominal price of which is 45s. 9d. per ton buyers, sellers 46s. 1½d. cash. The report current last week that a "corner" had been started in Cumberland hematite warrants has been since regarded as doubtful, and a large quantity of warrants has changed hands at irregular prices. The business varied from 57s. 3½d. to 58s. 0½d., and back to 57s. 7½d. cash, and 57s. 5½d. to 58s. 4d., and down again to 57s. 10d. one month.

The demand for hematite pigs, both English and Scotch, is very active, and reports of heavy covering purchases on behalf of the steelmakers have had a strengthening influence on the market. Scotch hematite pigs are quoted by merchants 60s. per ton, delivered at the steelworks.

The shipments of pig iron from Scottish ports in the past week amounted to 4613 tons, compared with 4950 in the corresponding week of last year. There was despatched to Canada 15 tons, South America 55, India 259, Australia 204, France 60, Italy 20, Germany 3665, Russia 200, Holland 580, Belgium 25, other countries 146; the coastwise shipments being 2590, against 1914 in the same week of last year.

The output of Scotch pig iron is fully maintained as well as that of hematite. In consequence of the scarcity of Cleveland iron, the demand for common brands of Scotch pig has been on the increase. There are thirty-two furnaces producing ordinary, forty-four hematite, and six basic iron, the total of eighty-two thus in operation in Scotland comparing with seventy-six at this time last year.

The stocks of pig iron in the Glasgow warrant stores continue gradually to decrease. There was a reduction in the past week of rather over 400 tons. The arrivals of Middlesbrough pigs at Grangemouth were 8000 tons, showing an increase of 1327 over those of the corresponding week.

The prices of Scotch makers' iron are well maintained, and are as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1 50s. 1½d.; Nos. 3 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 49s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Gartsherrie and Shotts, Nos. 1, 56s.; Nos. 3, 51s.; Calder, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Coltness, No. 1, 58s.; No. 3, 51s. 6d.; Glengarnock at Ardrossan, No. 1, 55s.; No. 3, 50s.; Eglinton at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Dalmellington at Ayr, No. 1, 51s. 6d.; No. 3, 50s.; Carron at Grangemouth, No. 1, 56s.; No. 3, 51s. per ton.

There is great activity in the manufacturing branches of the iron and steel trade, and rather better prices are being obtained. Common iron bars are quoted £6 17s. 6d., and best bars £7 5s.,

each less 5 per cent. This week's prices of mild steel are: Angles, £6 10s.; tees, £7 10s.; bars, £7 10s.; ship plates, £7; joists, £6 5s., all less the usual 5 per cent. discount for delivery in the Glasgow district.

The wages of iron makers have been advanced 2½ per cent., and there is steady employment.

Ironfounders are very well employed, and the various branches of the engineering trades are receiving their share of the general activity that prevails.

A large business is being done in the coal trade. The export department is more than usually well occupied. The shipments have been quite up to the average of the best weeks of this season, and it is reported that considerable sales have been made for delivery at Mediterranean ports over next year. The prices, f.o.b. at Glasgow, are, for main coal, 8s. to 8s. 3d.; splint and ell, 8s. 9d. to 9s.; steam, 9s. 3d. to 9s. 6d. per ton.

During November 23 new vessels were launched in Clyde shipyards, with a tonnage of 37,928, compared with 32 vessels and 37,928 tons in November, 1897. The output of the eleven months embraces 248 vessels, with an aggregate tonnage of 375,938, compared with 228 vessels and 270,739 tons in the corresponding period of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

CARDIFF coal shipment last week again touched 380,000 tons, and a satisfactory condition of things characterised all the ports. It is now tolerably certain that this will continue to the end of the year, and make up in a measure for the long stagnation of the strike, the only looming trouble so far is the threatened action by the Seamen's and Firemen's Union. On Monday evening there was a meeting of the union officials in Cardiff, when it was decided to take active steps at once to prevent any men belonging to their organisation signing on under £5 per month, or 32s. 8d. on weekly boats. This they stated—but it has been contradicted—is in conformity with the rate of wages in the North of England. In reference to this ukase, a Cardiff coalowner says that if persisted in he and others will "sign on" crews on the Continent. There is no difficulty now in getting men at £3 per month, but the majority of coalowners at Cardiff are now paying £4 to £4 5s. for monthly, and 30s. for weekly boats, and they say they are quite ready to fight the Union, and can get plenty of foreign seamen.

The Taff Vale men have very judiciously abandoned action consequent upon the concession given to them, and now I hope similar good policy will actuate the Seamen's Union, instead of endeavouring to stem the prosperity of the port. The activity prevailing is very gratifying, abundance of tonnage making collieries and railways as busy as it is possible to be. Last week afforded a series of large tonnages at Cardiff, Colombo on the 24th taking 5100 tons, and Perim 6000 tons, Port Said 8000 tons, La Plata 5400 tons, Genoa 5600 tons, Trieste 3900 tons, and Palermo 3750 tons. On the 25th 7100 tons went to Genoa, 4350 tons to Batavia, 4000 tons to Bombay, and 4500 tons to Nagasaki. This week again opened well, 3900 tons going to Perim, 4300 tons to Venice, and on one day, in addition to these, there were five consignments of 3000 tons and over, eight of 2000 tons and over, and ten of 1000 tons and above.

Newport coal shipments have included several of importance, one of 2000 tons to Genoa, and another of 2300 tons to Trieste. Swansea suffered somewhat from the stormy weather and delayed tonnage, but shipped over 43,000 tons. Newport, Mon., total last week was over 86,000 tons foreign and coastwise.

There is a tendency towards higher prices. This is shown in small steam, and in Monmouthshire semi-bituminous coal. Closing prices this week on 'Change, Cardiff, were as follows:—Best steam coal, 13s. to 13s. 6d.; seconds, 11s. to 12s. 6d.; dry, 10s. 6d. to 10s. 9d.; best Monmouthshire, 10s. 9d. to 11s. 3d.; seconds, 9s. 6d. to 10s.; special steam, small, 6s. 3d. to 6s. 6d.; best ordinary, 4s. 6d. to 5s. 6d.; seconds and inferior, 4s. to 4s. 3d.; best household, 13s. to 14s.; No. 3 Rhondda, 12s. 6d. to 13s.; No. 2 Rhondda, 8s. 6d. to 9s.; small, 5s. to 5s. 3d. It may be noted that best house coal is in improving demand, following closely upon the cold weather. In the district an ordinary figure for house coal delivered is 18s. 6d. to 19s. 6d.

Swansea prices:—Anthracite, 14s. to 14s. 6d.; seconds, 12s. 6d. to 13s.; ordinary, 11s. to 11s. 6d.; small rubbly culm, according to position on stem. Steam, 11s. to 11s. 3d.; seconds, 9s. 9d. to 10s. 3d.; bunkers, according to quality, 7s. 9d. to 8s. 3d.; small, 4s. 6d. to 5s. 9d. Bituminous coal: No. 3 Rhondda, 11s. 6d. to 12s. 6d.; No. 2 Rhondda, 9s. to 9s. 6d.; through, 7s. 9d. to 8s.; small, 5s. to 5s. 6d. Patent fuel, 10s. 9d. to 11s. Swansea-Cardiff prices, 11s. to 12s.

The boom in iron and steel continues, and is not unlikely to cause several important restarts. Attention is directed to the Treforest Works, which are kept in the best condition, and the proprietary being large capitalists, and in other ways interested in the iron and steel trades, a movement is not regarded as remote. This week it is rumoured that North's Navigation Collieries Company have been approached by a company with a view to take over Tondu furnaces and restart.

Welsh steel rails are very much in evidence, and India is a considerable customer. There was a shipment this week from Newport, Mon., of 2600 tons, and 400 tons coal for Bombay, and large stocking is now going on for the same destination at Cyfarthfa. These will be sent, when steamer is ready, to Cardiff for shipment. Both Cyfarthfa and Dowlais are busy supplying rail orders, and at the latter place steel sleepers, plates, and tin bars are being turned out in unusual quantity. At Cyfarthfa this week I had opportunities for seeing how favourably the large tin bar trade at these works tells upon the railway. The sidings were full of Taff Vale, Great Western, Rhymney, Midland, and Brecon wagons.

In connection with Cyfarthfa, the extended and improved Castle Mill is now in full going order, and everything is working satisfactorily, including the new invention of Mr. Evans, jun., the "stripper," which is very meritorious, and more than suggests a career of promise. Dowlais, I note, has blown in the old No. 1 blast furnace, and has such a large demand for pig that it is only met by consignments from the Cardiff works.

Blaenavon and Ebbw Vale are unremitting in their importations of ore from Bilbao and Castro, and the influx of northern pig into Swansea last week totalled the high figure of 4590 tons, Barrow, Maryport, and others figuring.

The steel works in connection with the Upper Forest Works, Morristown, are now in full swing. Mid-week the rolling mills started, and are to be followed by the tin mills and tin houses. The work has been divided into six-hour shifts, so as to give employment to as many hands as possible. Four mills will be started at the Worcester Works early in the New Year. A statistician notes that the Upper Forest Works have been idle for twenty-five weeks, and the Worcester for no less than twenty-six months.

It is known to the initiated that a good deal of first-class Japanese goods have been in past times turned out by some of the Welsh tin-plate works. I now learn that at Ynyspenllwch fresh plant is to be laid down for decorated Japanese goods, and the processes for making tin of every description will soon be in operation. Mid-week meeting on 'Change, Swansea, brought to light the fact that the operations of the bears and bulls are still continued, giving rise, as members remarked, to very great uncertainty as to the future, and causing some disorganisation in certain branches at present of the iron and steel trades.

It was admitted on all hands that the finished iron and steel works are fully employed, but owing to the anomalous position of the pig iron market, a difficulty in striking an average basis to replace and to enter new business is being experienced. In consequence new orders are being withheld until matters become more settled.

Another fact commented upon on 'Change was the abnormally high rate of wages paid to steelworkers, and grave distrust was expressed that this, unless modified, might increase the shipments of American steel to this country. It is known that these are steadily increasing.

Prices of tin-plate were reported as advancing, but not sufficiently so to cover extra cost of manufacture. American plates were stated as now being sold for home consumption at less than the equivalent price f.o.b. Swansea. This is regarded as bad enough; and, further, there is the possible outlook of the entry of American dealers into markets which Wales hitherto has supplied. Last week only 36,083 boxes were shipped, and 35,265 boxes received from works. Present stocks, 168,986 boxes.

The steel works of the Swansea Valley are busy. At Pontardawe an advance to "behinders" is likely, and an amicable settlement is expected at Cwmbwrla. Mannesmann Works are going steadily. The Manchester Zinc Company have now completed improvements, and smelting will begin at once. Spelter refiners are very busy in the district. An average business is being done at Briton Ferry and Llanelly. Closing prices iron and steel, mid-week, Exchange, Swansea, were as follows:—Glasgow pig iron warrants, 49s. 8½d., 50s. 0½d., 49s. 10d., 49s. 11½d., cash buyers. Middlesbrough No. 3, 45s. 9d. prompt, other numbers in proportion. Hematite warrants, 58s. 0½d. and 58s. for mixed numbers, f.o.b. Cumberland, according to brand. Middlesbrough hematite, 55s. 6d.; Welsh bars, £6 7s. 6d. to £6 10s.; sheet iron, £6 15s. to £6 17s. 6d.; sheet steel, £6 17s. 6d. to £7. Steel rails, heavy, £4 15s. to £4 17s. 6d.; light, £5 to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens, £4 15s. Tin-plate Bessemer steel cokes, 10s. 6d. to 10s. 9d.; Siemens, 10s. 9d. to 11s.; ternes, 19s. to 21s. 6d.; best charcoal, 12s. 6d. to 13s.; finished block plates, £8 to £8 10s.; Canadas, £7 to £7 10s. Block tin, £83 5s to £83 15s. Lead, £13 11s. 6d. Spanish, £13 8s. 9d.

Referring to the complete *résumé* of Welsh Bills in THE ENGINEER of last week, I hear that it is likely the Cardiff Railway authorities may figure in connection with the transformation scheme supported by them of substituting a rail for the canal from the north end of Abercynon Colliery. Evidence of authorities was given last year before Committee of the manifestly unsafe character of this part, and now I find it has been found imperative to stop the working of the canal at this point on account of subsidence. Parliament has on several occasions shown objection to do away with waterways, but the canal runs over a district that is honeycombed from the working of minerals underneath, and public safety is a serious question for consideration. One fact is certain, that from the 6th December this end will no longer be worked.

Wales is beginning to prepare for the London Welsh Water Bill. In the district affected I find, from personal observation, conflicting opinions prevailing. On one hand landowners look for substantial compensation to recoup. On the other, historical landmarks are threatened. I see that the Glamorganshire County Council have decided to oppose. Monmouthshire is favourably disposed, as the pipes will traverse the county.

Coke continues in full demand, and constant consignments from the Rhondda and other districts are being sent to the iron and steel works, and also exported. One cargo of 500 tons left Cardiff last week for Huelva, and coke forms part of many coal and steel shipments. Latest prices: Furnace, 16s. 6d. to 17s. 6d.; foundry, 18s. 6d. to 19s.; special, 24s. to 24s. 6d. Pitwood went up a few days ago 2s. per ton over last week's figures, but imports have been large, and the tendency is to the old scale of 18s. 6d.

There is a project on foot to replant the Forest of Dean, and the idea in the mind of the authorities is to select oaks. A much better and practical suggestion would be fir and larch for pitwood, and thus make the colliery districts less dependent upon France and Spain.

NOTES FROM GERMANY.

(From our own Correspondent.)

THERE is very little of special interest to be reported in connection with the general iron business this week. The tone all round is hopeful, there is plenty of work coming in, and activity in the various departments remains, consequently, brisk. The stiffness in quotations increases.

The Siegerland iron ore market has been showing remarkable animation; output, though very heavy, is scarcely equal to demand. In spite of this uncommonly satisfactory state of things, the iron ore convention has desisted from a rise in quotations for the present, though advances might be easily carried. Current rates are:—Raw spathose iron ore, M. 10 to 11 p.t.; roasted ditto, M. 14 to 15 p.t.; red minette (40 per cent. contents), M. 4·50 to 4·80 p.t.; gray minette, M. 2·60 to 2·80 p.t.; Nassau red iron ore, M. 10·50 p.t.; all net at mines.

The feature of the pig iron market in Rheinland-Westphalia, in the Siegerland, and in Silesia, is bright. A good local and foreign demand comes in for all sorts of crude iron; stocks have been cleared or have been reduced to the utmost. As to prices, an inclination to move upwards has been here and there perceptible, but official advances have not taken place. Very good accounts can be given of the plate business, especially where heavy sorts are in question. The endeavours of the Siegerland rolling mills to fix the lowest price for M. 140 p.t., and thus bring the quotations for sheets in just proportion to the prices for raw material, have been, on the whole, successful. Large lots of sheets have already been sold at M. 140 p.t. at works, and in many instances production for the next two quarters has already been disposed of. It is only in exceptional cases where contracts have been accepted at a lower price than that above mentioned. The prices quoted for sheets during the first two quarters of the present year have scarcely yielded any profit. The steel works are most actively employed, and the demand is, on the whole, in excess of the power of supply. Rivet iron cannot be obtained at less than M. 140 p.t., basis price. Bars and girders could not possibly be in better request than they are at present; the amount of orders booked is large. Rails and sleepers sell briskly, and the employment of the locomotive and wagon shops is regular and satisfactory.

The production of pig iron in Germany, including Luxemburg, is statistically stated to have been for October of present year 651,122 t., of which 129,130 t. were forge pig and spiegeleisen, 48,553 t. Bessemer, 362,403 t. basic, and 111,036 t. foundry pig. Output in September of present year was 614,497 t., while in October last year 611,779 t. were produced. From January 1st to October 31st of present year, 6,101,717 t. were produced, against 5,674,487 t. for the corresponding period the year before.

Deliveries of coal and coke during the period from the 1st to 16th of November of present year were in the Ruhr district 1,768,750 t., against 1,619,630 t.; from the Saar district, 257,440 t. were delivered, against 261,020 t.; from Silesia, 740,300 t., against 638,530 t.; and from the three districts together, 2,766,490 t., against 2,564,180 t. for the corresponding period in previous year.

Production as well as consumption of coal in Silesia is shown to have strongly increased since 1894, as may be seen by the following figures:—

Production.

	First quarter. Tons.	Second quarter. Tons.	Third quarter. Tons.
1894	4,221,623	3,908,902	4,417,489
1895	4,510,176	4,051,883	4,589,564
1896	4,897,704	4,473,004	5,051,778
1897	5,099,133	4,580,870	5,873,774
1898	5,611,214	5,041,960	5,798,995

Increase during these five years amounts to 3,804,000 tons, or 23 per cent.

Consumption of coal was as under:—

1894	3,763,181	3,529,412	4,129,503
1895	4,066,992	3,614,297	4 229,380
1896	4,505,372	4,014,803	4,672,168
1897	4,586,177	4,130,241	5,035,793
1898	5,007,467	4,622,050	5,498,691

The rise in consumption of coal amounts to 1,386,000 t., or 10 per cent.

Business in iron and steel moves on quietly on the Austro-Hungarian market, demand being moderate. Only from the Alpine districts an increasing inquiry is reported for merchant iron, and in Bohemia, too, the demand for some articles has improved. No change in prices has taken place recently.

A satisfactory condition is reported from the various iron trades in Belgium. The pig iron produced goes into immediate consumption, and the tone, generally, is firm. For plates and bars better prices have been obtainable. Ruling list quotations are as under:—Luxemburg foundry pig, No. 3, 56f.; common forge pig, 50f. to 53f.; merchant bars, f.o.b. Antwerp, No. 2, 127f.; No. 3, 132f. to 135f.; the same free Belgian station, No. 2, 133f.; No. 3, 137f. to 140f.; girders, f.o.b. Antwerp, 127·50f. to 130f.; the same free Belgian station, 132·50f. to 135f.; iron plates for export, No. 2, 140f. to 148f.; No. 3, 150f. to 160f.; steel rails, 110f. to 120f.; all per ton at works.

The different branches of the French iron industry remain well and regularly employed.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, November 25th.

THE abundance of money in all leading financial centres is a very important factor, and will probably result in a rush of projects from railroad building down to shops. Rates have fallen, and financial assistance is beginning to be more easily had. Numerous projects are now under consideration which may be undertaken in the spring. The hesitancy which has existed in business counsels for years is disappearing, and investors feel they are on firmer ground. There is a desire to launch out in many directions, and the preliminary investigations and conferences are going on. Trade combinations are under way in different industries, the tin-plate combination being the latest. The steel rail makers appear to have failed, temporarily at least. Smaller interests are getting together. For the iron and steel trades there is a growth of mill capacity, but furnace capacity is not much ahead of demand. The larger rolled iron manufacturers are still recognising the possibility of a greater demand next year than can be filled with the promptness that buyers desire. If there is any real probability of this, the fact will be shown in December by the anticipation of requirements in the placing of contracts. There is now a heavy pressure on all mills. They can take care of considerably more business, but buyers are easily scared. As soon as it is fixed as to steel rail prices for 1899 big orders will come. Other interests will begin heavy buying in that month. The demand for all kinds of merchant steel will tax mill capacity because of the purpose of most consumers to carry larger than customary stocks during 1899. Then quite a number of railroad companies are just about ready to place orders for cars, engines, shop equipments, and track requirements. It is not altogether clear how much this will amount to, but it will go far ahead of this year. The trade is apparently entering upon an era of expansion, and it understands it, but it is a matter of surprise in some quarters that so many consumers who will be obliged to place contracts in January at latest do not do so now, when manufacturers are half inclined to yield a little. There are no labour disturbances anywhere in the iron trade.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal is in good demand, but there is rather a scarcity of ready tonnage; prices remain firm. House coal is quiet, the weather having prevented the arrival of sailing vessels, but prices are firm. Exports for week ending November 26th were:—Coal, foreign, 63,181 tons; coastwise, 22,924 tons. Imports for week ending November 29th were:—Iron ore, 9157 tons; pitwood, 1850 loads; pig iron, 4400 tons; one cargo bog ore; 225 tons cement; 60 tons old iron.

Coal: Best steam, 11s. to 11s. 3d.; seconds, 9s. 6d. to 10s.; house coal, best, 13s.; dock screenings, 6s. 9d.; colliery small, 5s. 3d. to 5s. 6d.; smith's coal, 8s. Pig iron: Scotch warrants, 49s. 6d.; hematite warrants, 57s. 8d., f.o.b. Cumberland; Middlesbrough, No. 3, 46s. 6d. prompt. Iron ore: Rubio, 14s. to 14s. 3d.; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails, heavy sections, £4 15s. to £4 17s. 6d.; light ditto, £5 to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke 10s. 6d. to 10s. 9d.; Siemens—coke finish—10s. 9d. to 11s. Pitwood, scarce. London Exchange Telegram: Copper, £56 8s. 9d.; Straits tin, £83 12s. 6d. Freights: Firm.

TRADE AND BUSINESS ANNOUNCEMENTS.—The offices of Messrs. Ruston, Proctor and Co., Limited, will now be Stafford House, 27a, Cannon-street.—Messrs. Edward Le Bas and Co. inform us that they have been appointed sales agents for the export trade of the American Pipe and Foundry Company.

WATER DIVINING.—The Local Government Board, says the *Leighton Buzzard Reporter*, wrote stating that the appeal against the disallowance and surcharge of the sum of £13 8s. 7d. made by Mr. W. A. Casson, as district auditor, had been considered. The sum in question, continued the communication, appeared to have been paid to Mr. L. Gataker, who claimed to be an expert water finder, for his services and expenses in visiting the district and indicating where supplies of water could be procured for the use of the inhabitants. Proceeding, the letter stated:—"The auditor disallowed the payment for reasons which, in effect, are as follows: Firstly, that Mr. Gataker's claim to be able to discover subterranean sources of water was such a pretence as constituted an indictable offence, and that, therefore, the consideration for his employment was illegal and the contract void. Secondly, that in disregarding a certain geological report and employing Mr. Gataker, the District Council incurred expenditure without any sufficient ground, and recklessly wasted the public money under their control. Thirdly, that Mr. Gataker's claim to be able to discover subterranean sources of water was practically an attempt at imposition; and that, therefore, he was not a proper person for the District Council to employ. The auditor surcharged you with the sum disallowed on the ground that you authorised its payment, but it does not appear to the Board that his decision with respect to the disallowance and surcharge can be sustained. As regards the auditor's first reason, the Board do not consider that it has been proved that Mr. Gataker committed an indictable offence; or that, if he did so, the members of the District Council were aware that his pretences were illegal. This being the case the Board are of opinion that it must be held that the first reason assigned by the auditor fails to support his decision. As regards his second reason, the Board cannot but consider the action of the District Council as unwise; but it does not appear to them, having regard to the recommendations the Council received as to Mr. Gataker's capabilities, that the Council can be considered as having acted with such recklessness that the disallowance and surcharge can be confirmed on this ground. In view of the above considerations respecting the auditor's first and second reasons, the objection taken by him in his third reason appears to this Board to be insufficient to support his decision, and in the circumstances the Board propose to reverse the disallowance and surcharge. An order will shortly be issued accordingly."

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

16th November, 1898.

24,177. COLOURING MATTERS, Vidal Fixed Aniline Dyes, Limited, and L. Haas, London.
24,178. CALENDAR, S. Reid, Birmingham.
24,179. WIRE and other DRAW PLATES, J. E. Meredith, Birmingham.
24,180. APPARATUS for COIN-FREED METERS, J. Tourtel and The Tourtel Gas and General Engineering Company, Limited, London.
24,181. CYCLOMETERS, P. M. Justice.—(*The Veeder Manufacturing Company, United States.*)
24,182. DRIP RETAINERS for BOTTLES, E. Matthews, Thornton Heath, Surrey.
24,183. COLOURING MATTERS, Vidal Fixed Aniline Dyes, Limited, and L. Haas, London.
24,184. MOWING MACHINES, H. H. Lake.—(*J. F. Steward, United States.*)
24,185. LIGHTING CYCLES by ACETYLENE GAS, E Emptage, London.
24,186. SPAR CEILING CLEATS for SHIPS, W. Mullan, Belfast.
24,187. PUMP HOLDERS for CYCLES, H. Stone and W. White, Birmingham.
24,188. DRYING BRICKS, M. Villaret and J. B. Wahlen, London.
24,189. FIXING STEP to CYCLES, E. Aukland, London.
24,190. CIRCUIT BREAKER, H. H. Lake.—(*W. M. Scott, United States.*)
24,191. COLOURING MATTERS, Vidal Fixed Aniline Dyes, Limited, London.
24,192. PNEUMATIC TIRES for CYCLES, G. Hatchett, London.
24,193. BEARINGS for SHAFTING, J. A. Jamieson, London.
24,194. TREATING HORN, G. Rosenwald, London.
24,195. CRANK MECHANISM for CYCLES, E. Mattei, London.
24,196. ELECTRICALLY-HEATING PLATES, C. H. Kahrs, London.
24,197. BICYCLE STAND, W. P. Thompson.—(*V. Rockenmeyer, Germany.*)
24,198. BOXES, W. Sherratt, Liverpool.
24,199. DRIVING GEAR for CYCLES, M. B. Hern, Liverpool.
24,200. REFINING FATS, H. Cheetham, London.
24,201. CRADLES for SHIPS' BOATS, P. McQueen, Liverpool.
24,202. FOLDABLE GARDEN SEATS, S. W. Johnson, London.
24,203. CORSETS, G. C. Stephen, London.
24,204 TURBINES, S. Pitt.—(*A. C. E. Ra'eau and S Harlé and Co , France.*)
24,205. BICYCLE SUPPORTS and STANDS, C. Nicholson, London.
24,206. BILLIARD TABLES, J. B. King and F. R. Pool, London.
24,207. OPERA GLASSES, A. J. Baroux and H. V. Bion, London.
24,208. MOWING and REAPING MACHINES, P. W. Potter, London.
24,209. UMBRELLA DRIP CATCHER, C., J. B., and E. Lane, London.
24,210. BATTERY ELECTRODES, H. H. Lake.—(*v. d. Poppenburg's Elemente und Akkumulatoren, Wilde and Co., Germany.*)
24,211. DRYING WHITE LEAD, The East Ferry Road Engineering Works Company, Limited, F. S. Tuckett, L. Lancaster, W. W. and R. Johnson and Sons, Limited, and E. M. Johnson, London.
24,212. SPINNING MACHINE SPINDLES, T. Coulthard, J. H. Toulmin, T. Coulthard, jun., and E. Leach, London.
24,213. TEA INFUSERS, N. L. Scott, London.
24,214. FOOD CARRIERS, W. Maassen and W. Wirtz, London.
24,215. FOOD CARRIERS, W. Maassen and W. Wirtz, London.
24,216. SADDLES for CYCLES, W. M. White, London.
24,217. GOUGE, F. Soeding, London.
24,218. METAL TUBES, C. Hatton, London.
24,219. BELTS, W. H. Wheatley. — (*Mouilbau and Chevreau, France.*)

17th November, 1898.

24,220. TIRE RIMS, H. Looe and R. R. Gubbins, London.
24,221. CHAIN DRIVING GEAR, W. H. Weston, Liverpool.
24,222. LOCKING CARRIAGE DOORS, F. J. Whitehead, J. M. Stubbs, and H. Rogerson, Winsford, Cheshire.
24,223. STOPPERING BOTTLES, J. Gunning, Bournemouth.
24,224. GAS and OIL ENGINES, W. J. Boughton, jun., Thetford, Norfolk.
24,225. COOKING STEAMER, A. Cook, Margate.
24,226. WATERPROOF MATERIAL, L. Lenton, Coventry.
24,227. RAILWAY PLATFORM TRUCKS, J. Whittle, Chorley.
24,228. CALENDER ROLLERS of SCUTCHERS, C. Issenmann, Manchester.
24,229. TOBACCO PIPES, J. Fleux, Manchester.
24,230. WASHING PHOTOGRAPHIC PRINTS, R. Greenland, London.
24,231. VAPOUR GENERATING APPARATUS, E. S. Griffith, Manchester.
24,232. PIVOTS for CYCLE CHAINS, A. W. Brewtnall, Manchester.
24,233. TRICYCLE STEERING GEAR, J. R. and T. A. Bell, London.
24,234. BOTTLES, E. Ball, Walsall.
24,235. BAG for ICE, J. Robinson, Manchester.
24,236. WHEEL TIRES, L. Lenton, Coventry.
24,237. BOXES for PACKING EGGS and BOTTLES, J. Dunn, Glasgow.
24,238. VICES, W. Lent and A. Whitehead, Halifax.
24,239. GENERATING ACETYLENE GAS, W. J. Ginder, Birmingham.
24,240. WINDING ROPES of TRAWL GEAR, D. B. Walker, Glasgow.
24,241. OTTER TRAWL BOARDS and NETS, D. B. Walker, Glasgow.
24,242 SPIRITUOUS COMBUSTIBLE in SOLID FORM, J. Fischl, Manchester.
24,243. RING SPINNING FRAMES, J. and J. Potter, Manchester.
24,244. COVERING BRIDLE-BITS with INDIA-RUBBER, R. Craddock and Son, Birmingham.
24,245. COFFER-POTS and JUGS, F. Hauptman, Alloa, Scotland.
24,246 PENDENT WATER-TUBE BOILERS, C. P. Horton, Birmingham.
24,247. OPENING BOTTLES, R. Wroe and C. E. Williams, London.
24,248. FOG ALARM, E. A. Thompson, Parkgate, near Rotherham, Yorks.
24,249. LEAD TACK, H. Bradby and F. Bidwill, Brighton.
24,250. EXHAUST-PIPE TOP, W. Wright, London.
24,251. HAND TRUCKS, T. Holden, Birmingham.
24,252. SELF-ACTING BRAKE, J. Reeve and J. Fairfield, Blackburn.
24,253. UNION CASKS, W. Cutler, London.
24,254 FLAX SCUTCHING, A. McMinn, Donaghadee, Co. Down.
24,255. CYCLE STANDS, T. Humber, London.
24,256. KNITTING MACHINES, G. Flad, London.
24,257. TESTING LUBRICANTS, C. E. Vernon and A. Ross, London.
24,258. SPEED INDICATOR, A. W. Murray, Sandymount, Co. Dublin.
24,259. SELF-ADJUSTING FUDGE BOX, H C. Newman, London.
24,260. CLAMPING HOLLOW BODIES of GLASS, J. Fliegel, London.
24,261. DRIVING MACHINE TOOL SPINDLES, J. Fliegel, London.
24,262. CHAIN TELESCOPIC ELEVATOR, G. H. Noakes, Ilford, Essex.
24,263. CARRIER for LUGGAGE, T. S. Dean, London.
24,264. SWITCH for INCANDESCENT LAMPS, H. Hirst, London.
24,265. FILAMENTS for INCANDESCENT LAMPS, H. Hirst, London.
24,266. LEG COVERING for USE with SPATS, P. H. Davy, London.
24,267. COLLAPSIBLE CHESTS or BOXES, E. H. Archer, London.
24,268. COTTON THREADS, W. A. Phillips, London.
24,269. FIRE LIGHTERS, J. Blaske and H. Lederman, London.
24,270. MULTIPLE WALL CONNECTIONS for ELECTRIC LIGHTING, A. P. and G. C. Lundberg, London.
24,271. ROTARY COMPRESSOR for GASES, P. Whitney and W. Graaff, Cologne, Germany.
24,272. STEAM TURBINES, P. Whitney and W. Graaff, Cologne, Germany.
24,273. CHUCK for LATHES, K. Bauer, P. Whitney, and W. Graaff, Cologne, Germany.
24,274. GOLFING APPLIANCES, J. C. Jerrard, London.
24,275. BRAIDS, H. Warden, London.
24,276. MOTOR VEHICLES, W. P. Thompson.—(*The Cleveland Machine Screw Company, United States.*)
24,277. ELECTRICAL STOP MOTIONS for VALVES, W. P. Thompson.—(*F. E. Kip, United States.*)
24,278. LAMPS, P. A. G. Williams-Bailey, Liverpool.
24,279. FOG SIGNALLING APPARATUS, M. Gorman, Birmingham.
24,280. LIQUID-CONTAINING BARRELS, E. A. Olivieri, Birmingham.
24,281. CEMENT STEP, D. Janzi, London.
24,282. SPRINKLING MACHINES for MINES, H. Schäfer, London.
24,283. GAS IGNITER for INCANDESCENT MANTLES, F. Juhasz, London.
24,284. SKITTLE-BILLIARD TABLE, G. Staupe, London.
24,285. FIRE-PROOF CEILINGS, The United Asbestos Company, Limited, and J. A. Fisher, London.
24,286. AZO DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister Lucius, and Brüning, Germany.*)
24,287. PACKINGS for PISTONS R. H. Taylor, London.
24,288. GALVANISING IRON PLATES, H. Dachelet, London.
24,289. ZINC, V. Beaurang, London.
24,290. CINEMATOGRAPHIC APPARATUS, R. Simonau, London.
24,291. PRESERVING EGGS, B. Endler, London.
24,292. VELOCIPEDES, J Welker and F. Herrmann, jun., London.
24,293. GAS GOVERNORS, J. Goodson, London.
24,294. BRICKS, R. Bennett, London.
24,295. SUPPORTING BOARDS, W. R. Pryke and W. Palmer, London.
24,296. MILLING CUTTERS, C. G. and C. R. Garrard, London.
24,297. DAMPING-BOARD COVERS, F. Walters, London.
24,298 RAIL JOINTS, R. Price-Williams, London.
24,299. STEEL MUD-GUARDS for CYCLES, S. J. Kent, London.
24,300. STAND for DISPLAYING ARTICLES, I. T. Swarts, London.
24,301. PROPELLING BOATS, G. de Beer, London.
24,302 MACHINE for MOULDING CORES, C. Reinke, London.
24,303. HEEL and STRAP FASTENERS for BOOTS, F. Cook, London.
24,304. SAW-SAW, R. F. Hamilton and G. O. Starr, London.
24,305. COMPOSING MACHINES, P. E. Hodgkin and W. May, London.
24,306. SHIELDS for CIRCULAR SAWS, A. Foster, London.
24,307. EXTRACTING ZINC from ORES, J. C. Fell.—(*W. Strzoda, Germany.*)
24,308. ELECTRIC BATTERIES, H. J. Haddan.—(*Columbus Elektrizitätsgesellschaft m b. H., Germany.*)
24,309. INSTRUMENT for OPENING KNOTS, P. David, London.
24,310. BRAKE, H. J. Haddan.—(*Münchener Werkzeugmaschinenfabrik G. Hänsler and Co., Germany.*)
24,311. ROLLERS of DRAWING FRAMES, T. Wessel, London.
24,312. UTILISING HERTZIAN RADIATIONS, L. H. Walter, London.
24,313. BICYCLES, N. A., S. G., and W. Sawyer, London.
24,314. LABELS for KEYS, R. Pinnock.—(*A. H. Pinnock, Jamaica.*)
24,315. LEMON SQUEEZERS, R. Pinnock.—(*A. H. Pinnock, Jamaica.*)
24,316. ORIGINATING DESIGNS, G. F. and F. E. Ashley, Bradford.

18th November, 1898.

24,317. PRESSING APPLIANCES for SEAMS, W. D. Ford, Glasgow.
24,318. APPLIANCE for BRANDING CASTINGS, P. H. Ashley, Lincoln.
24,319. SIGNALLING TRAINS, W. S. Jervois, Blackrock, Co. Dublin.
24,320. WHEEL, A. Dove, Maidstone.
24,321. FERTILISERS, F. M. Mooney and A. Dickson, Dublin.
24,322. HORSESHOES, G. Bromley, J. E. Bott, and J. Boydell, Manchester.
24,323. STEAM GENERATORS, H. Kastrup, Newcastle-on-Tyne.
24,324. TRICYCLES, O. Recke, Glasgow.
24,325. ATTACHMENT for CHLORIDE INHALERS, A. Manners, Hull.
24,326. A KEYED MUSICAL INSTRUMENT, C. Brown, Burnley.
24,327. APPLIANCE for CHECKING PICKERS, E. Nuttall, Burnley.
24,328. SANITARY CHANNEL BLOCK, F. Denison, Normanton, Yorks.
24,329. GAUGE for USE with BANDSAWS, H. Rottenburg, Cambridge.
24,330. MUDGUARD BRIDGE, M. A. Weir, Kingston-on-Thames.
24,331. WHEELS, G. L. Scott, Manchester.
24,332. TOY PISTOLS, C. Turner, S. Bott, and F. A. Bird, Birmingham.
24,333. CYCLES, J. Sandeman, Birmingham.
24,334. APPLIANCES for CONSUMING SMOKE, E. Taylor, Blackburn.
24,335. DRYING BOTTLES, I. Mitchell and T. E. Dickinson, Huddersfield.
24,336. SCHOOL DESK STANDS, P. H. Taylor and C. D. Hedden, Bristol.
24,337. BOBBIN WHEELS, W. Sumner, Oldham.
24,338. FRAME for BUNKERS, F. Woollons, Stockton-on-Tees.
24,339. CUTTING CYCLE SPOKES, S. Broadbent, jun., Stretford, Lancs.
24,340. PNEUMATIC TIRES, B. Wheeler and C. N. Ainscough, Manchester.
24,341. BOOTS and SHOES, R. W. Mathers and G. Riley, Leicester.
24,342. OIL MOTORS, E. Billing A. Hallett, and The Endurance Motor Company, Limited, Coventry.
24,343. GOLF CLUBS, B. A. E. Hart, Birmingham.
24,344. COMPOSITION for DRESSING LEATHER, F. A. Cliff, Birmingham.
24,345. DISPLAYING ADVERTISEMENTS, C. Wright, Birmingham.
24,346. EXTENSIBLE LADDERS, W. Rose and J. G. Hall, Manchester.
24,347. PAPER-CUTTING MACHINES, L. and W. Crosland, Bredbury, Cheshire.
24,348. FASTENING BUTTONS, A. Rickmann. — (*The Heaton Peninsular Manufacturing Company, United States.*)
24,349. VELOCIPEDE ATTACHMENT DEVICE, R. H. Lee, London.
24,340. TROLLEY BRAKES, E. Bush and C. E. Rhodes, London.
24,351. DOMESTIC FIRE-GUARDS, T. Archer, Newcastle-on-Tyne.
24,352. PURIFYING ALE, G. C. Stewart and E. T. Zohrab, Glasgow.
24,353. CANDLESTICK SOCKETS, A. Barr, Glasgow.
24,354. RIMS for PNEUMATIC TIRES, S. H. Crocker, London.
24,355. GAME, H. Eisenmann, London.
24,356. CYCLOMETERS, W. I. Last, London.
24,357. BATTERIES, A. T. Ellis, London.
24,358. CYCLE CHAIN DRIVING GEAR, A. B. Matthews, London.
24,359. BICYCLE BRAKE MECHANISM, W. G. Hounsell, Birmingham.
24,360. CARRIAGE-DOOR FINGER GUARD, E. E. Hyatt, London.
24,361. BOX for DISPLAYING TABLETS of SOAP, The Maypole Company, Limited, and P. Villain, London.
24,362. CONSTRUCTION of CYCLE BRAKES, C. Owen, London.
24,363. THERMOMETERS for INCUBATORS, W. Tamlin, London.
24,364. INCANDESCENT MANTLES, R. Nordmann, Christiania, Norway.
24,365. TOBACCO PIPE MOUTHPIECES, J. G. Blatter, London.
24,366. PACKING RINGS, A. C. Brown and R. Burn, London.
24,367. VERMIN TRAP, C. Jackson, London.
24,368. AIR SHIP, E. Stavenow, London.
24,369. LIFEBOATS, F. N. Lyons, Kingston-on-Thames.
24,370. MOULDING SWEETSTUFF, A. C. Grube, Kingston-on-Thames.
24,371. ALTERNATING ELECTRIC MOTORS, The British Thomson-Houston Company, Limited.—(*C. P. Steinmetz, United States.*)
24,372. COCOANUT SHELL VESSELS, E. Zehnpfenning, London.
24,373. DYESOAP-POWDER MANUFACTURE, J. B. Koenig, London.
24,374. MULTIGLASINE FURNACE, T. Callow and R. Orrock, London.
24,375. PRODUCTION of RESIN SOAP, C. Dreher, London.
24,376. LETTER CARD, E. J. Harvey, London.
24,377. FOLDING OPERA GLASSES, W. R. Slade, London.
24,378. FIRE and ACID-PROOF MATERIAL, E. W. Engels, London.
24,379. TELEPHONES, F. L. Muirhead, London.
24,380. BOILERS, E. Taylor and S. T. Taylor, jun., London.
24,381. SLIDING WINDOW CONSTRUCTION, J. Hiscock, London.
24,382. MOTORS, H. L. Todd and J. Dunham-Massey, London.
24,383. PRODUCTION of DYE-STUFFS, H. E. Newton.—(*The Farbenfabriken vormals Friedrich Bayer and Co., Germany.*)
24,384. DISPLAYING ADVERTISEMENTS, E. S. Ratcliffe, London.
24,385. BAGS, O. Seefels, London.
24,386. STENCIL PLATE for PATTERN MAKING, H. Raynal, London.
24,387. DISPLAYING ARTICLES for SALE, H. Foxton, London.
24,388. EXERCISING APPLIANCES, H. Hiller.—(*A. A. Hendrickson, United States.*)
24,389. HATS, C. J. Ross, London.
24,390. SETTING HATS, A. Turner and F. Battersby, Manchester.
24,391. RESILIENT TIRES for VEHICLES, J. U. Burt, London.
24,392. VALVES for PNEUMATIC TIRES, T. Sloper, London.
24,393. CYCLE SPOKES, W. H Shephard and E. White, London.
24,394. LOCKING DEVICES for SECURING CAMS, F. M. Canda, London
24,395. SADDLES, H. Guillaume, London.
24,396. COMPOSITION for LAUNDRY USE, H Hobbs, London.
24,397. DRIVING GEAR of CYCLES, H. Guillaume, London.
24,398 SEATS, J. A. Shaw-Mackenzie and E. A. Crowsley, London.
24,399. CONVEYING APPARATUS, H. H. Lake.—(*T. S Müller, United States*)
24,400. TREATING COFFEE, R. C. E. Scarle, London.
24,401. LAMPS, W. T. Hagger, London.
24,402. CLEANING COMPOSITION, W. P. Thompson.—(*A. Kartschmaroff, Austria-Hungary.*)
24,403. PRESERVING EGGS, M. Marx, London.
24,404. EQUALISING ELECTRIC CURRENTS, L. Hackethal, London.
24,405. HINGES for FRENCH WINDOWS, A. Mauser, Liverpool.
24,406. TAPS, W. S. Worthington, Liverpool.
24,407. TRUCKS, J. H. Hebblethwaite, Liverpool.
24,408. PRODUCING ACETYLENE GAS, W. R. Ormandy, Liverpool
24,409. STORING GAS, W. W. Beech and H. Jones, Manchester.
24,410. MILK CHURNS, F. G. and W. Haworth, Manchester.
24,411. STARTING MECHANISM of CYCLES, G. Y. Cooper, Birmingham.
24,412. APPARATUS for DRAWING NETS, J. W. Pearson, London.
24,413. NETS, J. W. Pearson, London.
24,414. PLASMOLYSIS of YEAST, W. H. Wheatley.—(*G. Engels, Belgium.*)
24,415. ALARMS, E. J. Plymsell, London.
24,416. COIN-CONTROLLED APPARATUS, W. G. Temple, London.
24,417. INDUCTION MOTORS, W. Langdon-Davies, London.
24,418. ALTERNATING CURRENTS, W. Langdon-Davies, London.

19th November, 1898.

24,419. CORDS, A. H. and S. J. O'Brien and W. F. Pippet, Leicester.
24,420. JOINTS, H. P. Trueman, Handsworth, near Birmingham.
24,421. ROD, G. F. Baker, London.
24,422. REPLACING TIRES on WHEEL RIMS, R. Adams, Worthing.
24,423. FASTENERS for WINDOW SASHES, A. Chadwick, Manchester.
24,424. WASHING MACHINES, A. J. and J. B. Ziegler, Kingston-on-Thames.
24,425. ELECTRIC WIRE GAUGES, H. Lutz, Kingston-on-Thames.
24,426. RAILWAY CARS, P. C. Day and P. R. Cobb, Foyers, Invernesshire.
24,427. TOY, H. Hanks, London.
24,428. MUD-GUARD BRIDGE for CYCLE, G. Petts, Redditch.
24,429. CORSETS, E. Elaise, Manchester.
24,430. CHAIR WHEELS, C. H. Guest, Ockbrook, Derbyshire.
24,431. COATING SHEETS, W. Morgan and G. S. Richmond, Llanelly.
24,432. GAME, E. W. Brock, Bristol.
24,433. DYEING YARN, F. Davis and A. Liebmann, Manchester.
24,434. HAND TRUCKS, J. J. and C. H. Taylor, Nottingham.
24,435. RECORDING the MOVEMENTS of SHIPS, W. H. Bailey, Manchester.
24,436. STARCHING and IRONING CLOTHES, C. L. Moore, Leeds.
24,437. ENGINES, J. Thom, Liverpool.
24,438. VOLTAIC CELLS ACCUMULATORS, C. M. Stead, Leeds.
24,439. CYCLE CHAIN ADJUSTMENTS, C. B. Harrison, Birmingham.
24,440. CYCLE FOOT REST, W. E. and J. P. Grosvenor, Wolverhampton.
24,441. INFLATING PNEUMATIC TIRES, A. G. Turner, London.
24,442. LIQUID-DISTRIBUTING APPARATUS, J. Craven, jun., Manchester.
24,443. PREVENTING PUMPS CLOGGING, F. Pearson, Bilston, Staffs.
24,444. PROPELLING APPARATUS, F. G. I. Lillingston, London.
24,445. KNITTED FABRICS, T. Mawby, London.
24,446. WASHING MACHINES, S. J. and S. A. Pegg, London.
24,447. CONDUITS for ELECTRIC TRACTION, T. W. Barber, London.
24,448. BOILER FLUE DRILLING MACHINE, V. H. Coates, Belfast.
24,449. BICYCLE CRANKS, J. Turnbull, Plumstead, Kent.
24,450. BICYCLE CRANK BRACKETS, W. H. Fauber, Glasgow.
24,451. BICYCLE CRANK BRACKETS, W. H. Fauber, Glasgow.
24,452. FORK for BICYCLE FRAMES, W. H. Fauber, Glasgow.
24,453. INKSTANDS, P. L. Hall, Manchester.
24,454. VELOCIPEDES, J. Hilgers, Liverpool.
24,455. TOBACCO PIPES, W. J. Beames, London.
24,456. OIL PURIFIERS, D. H. McClelland and S. J. Butterfield, London.
24,457. SMOKING PIPES, J. Wheeler, London.
24,458. ACETYLENE GAS LAMPS, C. H. Wormop, Halifax.
24,459. ENGINES, J. H. Street, M. H. Robinson, and M. H. P. R. Sankey, London.
24,460. ENGINES, J. H. Street, M. H. Robinson, and M. H. P. R. Sankey, London.
24,461. WATER-TUBE BOILERS, M. H. Robinson, London.
24,462. CENTRIFUGAL ENGINES, M. H. P. R. Sankey, London.
24,463. STOVES, H. Hentschel, London.
24,464. FLOAT-ACTUATED ENGINE, H. and S. H. Hawkins, London.
24,465. DRESS PRESERVER, W. P. Thompson.—(*Metzeler and Co., Germany.*)
24,466. ELECTRIC INCANDESCENT LAMP, W. N. Stewart, London.
24,467. HEAD-LOCKS for BICYCLES, C. H. Shacklock, London.
24,468. EXPLOSIVES, E. A. G. Street, London.
24,469. PULLEYS, J. H. Goodwin, London.
24,470. ENGINES, A. Clerk.—(*A. Mauricon, France.*)
24,471. X-RAYS, F. Holmes, Bristol.
24,472. SPOKES, C. T. Austen, London.
24,473. THRUST BLOCKS, J. W. Muse, London.
24,474. SIFTING MACHINES, F. Badeau, London.
24,475. SPLITTING STONES, K. Kreuzer, London.
24,476. VANE, The British Henrici Laundry Machinery Company, Limited.—(*W. A. E. Henrici, United States.*)
24,477. LOCKING BARS, J. Wilson and W. Pugh, London.
24,478. BRAKES, A. Wood, London.
24,479. CRUCIBLES, J. W. Woolford, London.
24,480. RAIN-WATER PIPES, C. W. H. Bathurst, London.
24,481. MUTOSCOPES, C. Raleigh, London.
24,482. TOBACCO PIPES, E. W. Thurgar, London.
24,483. REMOVING IMPURITIES from WOOL, C. Delerue, London.
24,484. BLEACHING FABRICS, W. Mather and R. H. Haworth, London.
24,485. CONTROLLING COCK, G. Wiberg. London.
24,486. STORING ENERGY, E G. Nicholson and F. W. Adams, London.
24,487. CONTACT-MAKING DEVICES, C. Steiner, London.
24,488. DISPLAYING ADVERTISEMENTS, F. N. Mackay, London.
24,489. CLOSING TIN BOXES, P. Pollitzer, London.
24,490. TWIN GRATER, S. A. Greene, Winchester.

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24,491. CEMENT, A. J. Keeble and G. H. Innes, Hitchin, Herts.
24,492. HOLLOW BLOOMS, J. G. Inshaw, Gravelley Hill, near Birmingham.
24,493. GENERATION of ACETYLENE GAS, J. H. Exley, Huddersfield.
24,494. LUBRICATORS, A. F. Cole, Kidderminster.
24,495. BACK-REDUCING MACHINE, E. R. Polehampton, Frome, Somerset.
24,496. PIPES, C. Bollé.—(*S. Bergmann and Co. Actiengesellschaft, Germany.*)
24,497. PORTRAIT FRAME for TOMBSTONES, E. Chatham, Manchester.
24,498. WATER-EVAPORATING APPARATUS, J. Davie, Glasgow.
24,499. SECURING LABELS, T. Boville, Stockton-on-Tees.
24,500. STEAM GENERATORS, J. Blake, Middlesbrough, Yorks.
24,501. GENERATORS for ACETYLENE, W. Ellen, Manchester.
24,502. CYCLE STANDS, J. J. Ware, Bristol.
24,503. PURIFICATION of TOWN SEWAGE, E. Filch, Aldershot.
24,504. STOVES, W. M. Simpson, Hastings.
24,505. TREATMENT of PIG SKINS, J. Muir, Beith, Ayrshire.
24,506. POWDER BOX and PURSE POCKET PUFF, E. Cumming, London.
24,507. SOLES for BOOTS and SHOES, A. N. Nixon, Devonport.
24,508. ELECTRIC TRACTION, P. Pinckney, Portsmouth.
24,509. ANNEALING POTS, H. Langen, Barmen, Germany.
24,510. SELF-ACTING CLIPS, W. H. Young and J. Hunt, Manchester.
24,511. BOTTLE STOPPER, E. J. Collins and C. Williams, Loughborough.
24,512. BITS for HORSES, N. Behrens and N. B. Smith, Glasgow
24,513. KIT BAG FRAMES, F. Spiegelhalter, London.
24,514. FORK CLEANER, &c., G. H. Bamforth, London.
24,515. COLLAPSIBLE BOXES, J. Broady and T. Small, London.
24,516. HOOKS for CLOTHES, E. E. and J. T. Rieley, Birmingham.
24,517. PHOTOGRAPHIC CAMERA STAND, M. van Praagh, London.
24,518. APPARATUS for COOLING LIQUID, J. G. Davies, London.
24,519. STOVE SETTINGS, W., J., and E. Rockhill, London.
24,520. BILLIARD CUE, F. Offen, Barnes, Surrey.
24,521. BEDSTEADS, R. Pinnock.—(*A. H. Pinnock, Jamaica.*)
24,522. CONNECTIONS for TUBES, W. Barnaley, Birmingham.
24,523. TOY, J. Bowden, Guildford.
24,524. AUXILIARY MOTIVE POWER, J. Bowden, Guildford.
24,525. LOOMS, G. O. Draper, London.
24,526. CIGAR and CIGARETTE HOLDER, G. T. y Ventura, London.
24,527. RAILWAY LUGGAGE TROLLEYS, W. Griffiths, Birmingham.
24,528. COIN-FREED FORTUNE TELLER, H. J. G. Peasers, London.
24,529. BELTING FASTENER, J. Begg, London.
24,530. ELECTRIC ACCUMULATOR, C. T. J. Oppermann, London.
24,531. CYCLE STAND, G. Woodruffe, London.
24,532. ELECTRIC CABLES, B. J. B. Mills.—(*La Société Française des Câbles Electriques, Système Berthoud, Borel, et Cie., France.*)
24,533. MECHANICAL MOTION, W. P. Thompson.—(*C. S. Bradley, United States.*)
24,534. HAIR PINS, W. P. Thompson.—(*C. A. Meldrum United States.*)
24,535. TOOL HOLDER, F. I. Shellhammer and S. C. Garner, Liverpool.

24,583. CARDBOARD SAMPLE BOXES, A. E. Wade, Manchester.
24,537. LEAF TURNER, G. Nippard and G. White, London.
24 538. BLACK SULPHUROUS DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
24 539. BRAKES for MOTOR CARS, &c., E. Cuénod, London.
24,540. HYDRAULIC PRESSES, C. D. Abel.—(*Haniel and Luey, Germany.*)
24,541. INTERNAL COMBUSTION ENGINES, F. Strickland, London.
24,542. LIQUID-STERILISING APPARATUS, B. H. Tindal, London.
24,543. OZONE GENERATING APPARATUS, B. H. Tindal, London.
24,544. GUNS, J. H. Meigs and S. A. S. Hammar, London.
24,545 PEDAL GEAR and AUTOMATIC BRAKE GEAR, J. Feiteison and J. M. von Berg, London.
24,546. BOXES, E. Harrison, London.
24,547. AIR VALVES, T. Shepherd, London.
24,548. SHOW CARDS, S. Lynn and M. Stevenson and Ott, Limited, London.
24,549. MOSAIC PICTURES, B. Humayer, London.
24,550. ELECTRO-THERAPEUTIC and MASSAGE APPARATUS, O. Schneider, London.
24,551. NECKTIES, E. S. Canman, London.
24,552. SAFETY FASTENINGS for ENVELOPES, T. Hawkins, London.
24,553. MUSIC CASES, C. Davis, London.
24,554. BREECH-LOADING ORDNANCE, S. Pitt.—(*F. F. Fletcher, United States.*)
24 555. MAKING GUNPOWDER A. G. Bell, London.
24,556. SMOKE-CONSUMING FURNACES, A. Skeffington and J. B. O. and T. E Shevill, London.
24,557. INCREASING the HEATING EFFICIENCY of FLAMES, R Pringle, London.
24,558. SPRING STUD CLIP, C. Hechtle, London.
24,559. ELECTRICALLY-PROPELLED VEHICLES, H. G. Morris and P. G. Salom London.
24 560. ADJUSTABLE HAND-GRIPS, F. Taylor, London.
24,561. CYCLE SADDLES, F. Lacour, London.
24,562. FLOATING VESSELS, M. Chenivesse, London.
24,563. DYNAMO ARMATURES, A. C. J. Guénée, London.
24,564. MIXING SUBSTANCES, D. W. Wall, London.
24,565. FOLDING VEHICLE CANOPIES, A. S. Burnham, London.
24,566. OPENING ELECTRIC CIRCUITS, G. C. Fricker, London.
24 567. PHOTOGRAPHIC CAMERAS, J. C. Fell.—(*J. G. Siegrist, France.*)
24,568. TYPEWRITERS, J. C. Fell.—(*The American Writing Machine Company, United States.*)
24,569. COUCH, A. Fisher, London.

22nd November, 1898.

24,570. ELECTRIC BATTERIES, W. S. Rawson, London.
24,571. WELT-CUTTING MACHINES, F. Shellard, Bristol.
24 572. BUNGHOLE FITTINGS for CASKS, W. Homann, Berlin.
24,573. RING SPINNING APPARATUS, J. Hargreaves, Bolton.
24,574. BUTTED-POINTED PENS, A. E. Wright, Birmingham.
24,575. SELF-SUPPLYING INK BOTTLE, J. J. Duffy, Dublin.
24,576. STAMPING MARKS on MATERIALS, R. Wallwork, Manchester.
24,577. DROP HAMMER BELTS, J. Taylor, Liverpool.
24,578. TUFTED FABRICS, C. S. E. Spoerl, Wolverhampton.
24,579. STEAM VALVES, J. Hutcheson and J. F. Service, Glasgow.
24,580. DEADENING SOUND of ENGINES, H. T. Melling, Liverpool.
24,581. TRAP, A. Lane, Norwich.
24,582. DESTRUCTORS for REFUSE, &c., J. Willoughby, London.
24,583. CIGARETTES, P. White, Manchester.
24,584. GAME as an ADVERTISEMENT, W. C. Haigh, Manchester.
24,585. HANDLE-BARS for CYCLES, J. Hammond, Birmingham.
24,586. KNIFE, J. S. Warburton and J. Wheeler, Waterloo, Lancs.
24,587. VEHICLES, W. H. Milligan and A. Henderson, Glasgow.
24,588. ENGINES, S. Drummond and T. Abbott, Bradford.
24,589. FASTENERS for DRIVING BELTS, D. Littlewood, Manchester.
24 590. DISCHARGE VALVES for BATHS, J. Simpson, Glasgow.
24,591. EXTENSIBLE BILLIARD REST BUTT, T Watson, Glasgow.
24,592. DOOR SILENCER, G. B. Thornton, Glasgow.
24,593. IGNITING LAMPS with ELECTRICITY, O. Y. Rhodes and The Miners' Lamp Electric Lighting Company, Limited, Halifax.
24,594. FOLDING PARCELS, A. Forbes and F. Glover, Manchester.
24,595. FASTENINGS for LEGGINGS, &c., F. Jones, Chester.
24,596. TOE CLIPS for CYCLE PEDALS, E. W. Duffill, Birmingham.
24,597. ACETYLENE GENERATORS, A. W. Sanderson, Birmingham.
24,598. TINS, Sutton's Stamping Company, Limited, R. H. Hepburn, Birmingham.
24,599. MOUNTING ENTOMOLOGICAL OBJECTS, A. Watson, jun., Birmingham.
24,600. MIXING PULP, J. Almond and S. F. Andrews, Bath.
24,601. TOBACCO PIPES, H. A. T. Skyrme, Newport, Mon.
24,602. VEHICLE WHEELS, H. G. Morris, London.
24,603. KILNS for BRICKS, W. F. Mason and W. H. Wilson, Manchester.
24,604. AUTOMATIC FLUSH CLEAT, W. Holmes, Manchester.
24,605. SECONDARY BATTERY PLATES, W. H. Hanson, London.
24,606. SPRING HOOKS, C. F. Hurst, Birmingham.
24,607. BEARING for SHAFTS, W. E. Hollier, Birmingham.
24,608. INDICATING the GRADIENTS on ROADS, F. and J. Jeffery, Birmingham.
24,609. GAS ENGINES, E. E. Allyne and R. G. Anderson, Glasgow.
24,610. ROLLING STEEL RAILS, F. W. Ratcliff, J. H. Pearson, and P. Robinson, Birmingham.
24,611. ROPE CLAMP, W. H. Bomm, New York.
24,612. SADDLERS' LEATHER-CUTTING PUNCH, M. Reynolds, Walsall.
24,613. GRAB DREDGERS, J. R. Bell, London.
24,614. WATER-HEATING for STEAM BOILERS, J. E. Carroll, London.
24,615. BUNKING MACHINES, W. Jackson, London.
24,616. SEAT WHEELING MACHINES, W. Jackson, London.
24,617. PNEUMATIC TIRES, F. C. Hunt, London.
24,618. INCUBATORS, C. S. Newsom, London.
24,619. COIN-CONTROLLED BICYCLE STAND, D. B. Austin, London.
24,620. TUBE-BENDING APPARATUS, L. H. Brinkman, London.
24,621. VELOCIPEDE MUDGUARDS, J. H. Edwards, London.
24,622. EMBROCATION, J. England, London.
24,623. PRODUCING ACETYLENE GAS, F. W. Newman and A. H. Critchley, London.
24,624. DISTRIBUTING TYPE, The Linotype Company, Limited.—(*The Thorne Type-setting Machine Company, United States.*)
24,625. HORSE ROUGHER, R. Prosser and H. Chapman, London.
24,626. MICROPHONIC BOXES, E. Hardy and A. Picard, London.
24,627. FUEL, S. Bandrowski, London.
24,628. DRYING VEGETABLE WASTES, E. Löwi, London.
24,629. PRODUCING ASPHALT, A. E. Alexander.—(*D. W. Peck, United States.*)
24,630. PRODUCING ASPHALT, A. E. Alexander.—(*D. W. Peck, United States.*)
24,631. ANIMAL and POULTRY FOOD, J. H. Speyerer, London.
24,632. FLY TRAPS, R. Paul, London.
24 633. CORKING BOTTLES, G. V. De Luca and S. Hill, London.
24,634. VELOCIPEDE FRAMES, J. Watson, T. Kenyon, and M. Moore, London.
24 635. HORSESHOES, J. H. Fitter, London.
24,636. CYCLES, J. Howard, London.
24,637. CYCLE-FORK BEARINGS, W. G. Davies, London,
24,638. VENTILATED HAT MIRROR, J. Boam, London.
24,639. BOOT-SEWING MACHINES, M. C. Mullarky and W. H. Hingston, London.
24 640. KNIVES for SKINNING ANIMALS, P. F. Payan, London.
24,641. SECONDARY BATTERIES, N. H Edgerton and A. H. Masters, London.
24,642. ADJUSTABLE BEARING BRACKET, W. T. Rounsivell, London.
24,643. PRODUCING LIME, H. C. Bull, A. C. Oakes, and T. M. Thom, London.
24,644. WRITING INK, L. and A. Lichtentag, London.
24 645. POLISHING COMPOUNDS, B. Benville and J. S. Muriaty, London.
24,646. COMBINED PIANO PLATE and BACK, F. V. Neuville, London.
24,647. DEVICE for CLOSING BOTTLES, J. D. Roche, London.
24,648 MATS for PREVENTING SLIPPING, J. E. Platt and C. S. Madao, London.
24,649. CLEANING SMOKING PIPES, J. G. Warren, London.
24,650. FASTENING DEVICES for GLOVES, L. N. Littauer, London.
24 651. TROUSER STRETCHER, A. T. Powell, Birmingham.
24,652. MINERS' DRILLS, H. Aylmer, London.
24,653. INCANDESCENT GAS MANTLES, H. G. Semadeni. (*U. C. Locwy, Austria-Hungary.*)
24,654. CHAIN-ADJUSTING DEVICES for VELOCIPEDES, H. H. Lake.—(*Crosby and Mayer Company, United States.*)
24,655. ELECTRIC CABLES, E. T. Greenfield, London.
24,656. SEWING MACHINES, J. Vannette and C. J. Yingling, London.
24 657. VICES, A. Wachtl, London.
24,658. GRAIN-BINDING APPARATUS, H. H. Lake.—(*Deering Harvester Company, United States.*)
24,659. MOULDING CUPS of CLAY, &c., H. Briggs, London.
24 660. COLLECTING NUMBERED CHEQUES, E. A. Henkle, London.
24,661. TURNING LATHES, J. Brockie, London.
24,662. EXPLOSIVES, A. Luck, London.
24,663. APPLYING LABELS to BOXES, E. Jagenbergh, jun., London.
24,664. UTILISING the FORCE of WATER CURRENTS, G. Wilson, London.
24 665. COVER for FISH BARRELS, F. Köhn, London.
24,666. TROUGHS for DISTRIBUTING SEWERAGE, W. M. Ducat, London.
24,667. ENVELOPES for POSTAL MATTER, J. A. McRobert and D. L. Jones, London.
24,668. WATERPROOF COVERS for CYCLE SADDLES, J. C. Rosco and W. J. Dalton, London.
24 669. ANEROID BAROMETERS, H. S. P. Watkin, London.
24,670. LAMPS for BURNING PETROLEUM, G. W. Lyth, London.
24,671. LACES, &c., J. Wardall and C. Martin, London.
24,672. BOOK-SEWING MACHINES, C. Welch, London.
24,673. COIN-CONTROLLED MECHANISM, I. Clifford, London.
24 674. DESKS, E. P. Bainbridge, London.
24 675. PRESERVING PERISHABLE ARTICLES, L. W. Sterne, London.
24,676. CYCLE SEAT PILLARS, H. F. Herring and R. Squibb, London.
24,677. SHOVELS, T. E. Rennie, London.
24,678. MATCH STRIKING DEVICE, W. V. Gough, London.
24,679. CHIMNEYS for GAS LAMPS, F. Higgins, London.
24,680. BITS, E. Burrows, London.
24,681. GLANDLESS GAUGE GLASS SOCKET, E. H. Sholl, London.
24,682. ACETYLENE GAS GENERATORS, O. Falbe, London.
24 683. DRYING SAND and LOAM MOULDS, N. Shaw, Liverpool.
24,684. PAPER BAGS, G. E. Sharp, Liverpool.
24,685. GAITERS, F. J. Stohwasser and G. B. Winter, London.
24,686. TYPEWRITER ATTACHMENTS, L. Schlesinger, London.
24,687. TIRES for WHEELS of CYCLES, W. Butler, London.
24,688. TOY GUN, W. H. Calkins, C. A. Lindberg, W. M. Butt, and A. K. Wheeler, London.
24,689. TOY GUN, W. H. Calkins, C. A. Lindberg, W. M. Butts, and A. K. Wheeler, London.
24,690. TOY GUN, W. H. Calkins, C. A. Lindberg, W. M. Butts, and A. K. Wheeler, London.
24,691. DEVICE for PREPARING MALT, R. Pitschke, London.
24,692. CHAINLESS CYCLE DRIVING GEAR, L. Schorn, London.
24,693. VALVE SPOUT for KETTLES, W. P. Ellmore, London.
24,694. REGULATING LAMP FLAMES, W. P. Ellmore, London.
24,695. ADVERTISING LAUNDRY REGISTER, P. H Senior, London.
24,696. ACETYLENE SAFETY MINING LAMP, T. G. Macfie, London.
24,697. UNITING PULLEY BELT ENDS, G. W. Webb and F. A. Schmidt, Kingston-on-Thames.
24,098. STOVES, S. A. Hazlewood, Kingston-on-Thames.

23rd November, 1898.

24,699. HORSE SADDLES, T. B. Selby, Birmingham.
24 700. INTER-COMMUNICATION in TRAINS, W. E. Langdon, Derby.
24,701. SPRING SHUTTLE CHECK for LOOMS, T. Haworth, Darwen, Lancs.
24,702. POCKET MAPS, W. C. Hopekirk, Edinburgh.
24,703. FOLDING UMBRELLA STAND, S. S. Seccombe, London.
24,704. ACETYLENE GAS GENERATOR, R. W. Spittlehouse, Wombwell, Yorks.
24,705. EMPTYING BATHS, T. W. Twyford, Birmingham.
24,706. MATCH-BOXES and CIGAR CASES, F. W. T. Turton, Birmingham.
24,707. JOINTING BICYCLE FRAMES, D. Crowther, Huddersfield.
24,708. INTERLOCKING SIGNAL LEVERS, D. S. Burns, Glasgow.
24,709. CHIMNEY-POTS, J. H. Oxley and R. Williamson, Stockton-on-Tees.
24,710. RAILWAY TRUCKS, D. Jones, Stockton-on-Tees.
24,711. FOLDING DOORS for TRAMWAY CARS, J. Preston, Cardiff.
24,712. RAISING SUNKEN OBJECTS, W. E. Syor, Manchester.
24,713. PROPELLER-SHAFT BEARINGS, A. J. Amos, Newcastle-on-Tyne.
24,714. TROLLEYS for ELECTRIC TRACTION, R. Hill, Newcastle-on-Tyne.
24,715. CAMERAS, R. and M. Ballantine, Glasgow.
24,716. VALVE GUARD, T. Kettle and W. Foster, Dungannon, Co. Tyrone.
24,717. CONNECTING CRANKS to AXLES, R. Dewandre, fils, Birmingham.
24,718. CORKING-MACHINE LOCKING MECHANISM, J. R. Lofthouse, Barnsley.
24,719. WASHING SCREW STOPPERS, J. R. Lofthouse, Barnsley.
24,720. CUPS of STOPPERING MACHINES, J. R. Lofthouse, Barnsley.
24 721. AUTOMATIC LOCK, G. F. Shimmin, Maryport, Cumberland.
24,722. MAKING PIPE JOINTS SAFE, J. B. Hamilton, Tenby, South Wales.
24,723. FASTENING SUPERPOSED FABRICS TOGETHER by PRINTING, J. K. Empsall, E. R. Firth, and G. F. Ashley, Bradford.
24,724. PRESERVED CREAM PREPARATIONS, P. L. Dithmer, London.
24,725. OIL FILTERS, W. C. Barns, London.
24,726. REGISTERING RACE WINNERS, J. Kerr, Newmilns, Ayrshire.
24,727. MEASURING a SUPPLY of ELECTRICITY, W. A. Price, London.
24,728. COIN-FREED GAME, R. E. Wickes, London.
24,729. PREVENTING SHIPS SINKING, H. E. H. Smedley, London.
24,730. FIRE-GRATES and HEATING STOVES, J. W. Bowley, London.
24,731. GARMENTS, L. Mabee, London.
24,732. EGG HOLDER, H. J. Marks, London.
24,733. TIE CLIP, G. Ranking and A. C. Downing, London.
24,734 ELECTRIC TRACTION, P. Pinckney, Portsmouth.
24,735. EXHIBITING ANIMATED PICTURES, G. Barrow, London.
24,736. COVER SEAT, B. Rogers. London.
24,737. PASTEBOARD-BENDING MACHINE, C. F. Rosencrantz, London.
24,738. SPROCKET CHAINS and WHEELS, H. W. Bradley, London.
24,739. PUZZLE, R. J. C. Collins, London.
24,740. EXTRACTING OIL from SEEDS, G. Mitchell, London.
24,741. REMOVING IMPURITIES from LIQUIDS, J. T. Bennett, London.
24 742. ADJUSTMENT for WATCH REGULATOR, W. E. S. Debenham, London.
24,743. BI-FOCAL SPECTACLES, W. E. Debenham, London.
24,744. CHRYSANTHEMUM CLIP, F. C. Watts, Eltham, Kent.
24 745. SHIRTS, A. H. Hardy, London.
24,746. DOOR LOCK, A. E. Jones and T. H. Cadreman, London.
24,747. ELECTRIC SPARKING DEVICES, E. Houpied and C. V. Girard, Liverpool.
24,748 CHAIN SPROCKETS for CYCLES, K. J. Karlqvist and A. L. Pottersson, Liverpool.
24,749. IRON and STEEL, W. Ivanoff, London.
24,750. PHOTOGRAPHIC NEGATIVES, O. Moh and A. Hesekiel, London.
24,751. FERMENTATION for PRODUCING ALCOHOL, J. Heron, London.
24,752. COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
24,753. MAGAZINE CAMERAS, A. J. Boult.—(*P. F. E. Laux, Germany.*)
24,754. HEEL SPRINGS for BOOTS, &c., G. E. Swan, London.
24,755. ARMOUR for MOTOR CARS, C. M. Johnson, London.
24 756. CRICKET BAT HANDLES, W. C. Rylands and G. F. Carlton, London.
24,757. LEAD PLATES for BATTERIES, M. Wuillot, London.
24,758. MOTOR-PROPELLED VEHICLES, H. J. Lawson, London.
24 759. SPEED-CHANGING MECHANISM, D. A. Renard, London.
24,760. REGULATING APPARATUS for ROTARY MOTORS, T. U. Gray, London.
24,761. INSTRUMENT for FACILITATING TRIGONOMETRICAL ADMEASUREMENTS, F. J. Bayldon and A. H. Armstrong, London.
24,762. DECORATION of ARTICLES of WOOD, H. H. Lake. —(*G. Campanato, Italy.*)
24,763 ROLLER MILLS, C. D. Phillips and J. Pring, London.
24,764. MACHINES for MAKING SLAT AND-WIRE FABRICS, G. P. Fisher, jun., and J. Reif, jun., London.
24,765. WOODENWARE PACKAGES, G. P. Fisher, jun., and J. Reif, jun., London.
24,766. PNEUMATIC TIRES, Hellsterns Syndicate, Limited, and N. P. W. Brady, London.
24,767. PRIMARY AZO-DYES, Société Française de Couleur d'Aniline de Pantin, E. Ruch, and G. Nuth, London.
24,768. STEEPING VEGETABLE TEXTILE FIBRES, A. Bouret and F. Verbiese, London.
24,769. NECKTIES, F. Theak, London.
24,770. VAPORISER for GASEOUS POWER ENGINES, T. Myers, London.
24,771. GAS GENERATORS, F. W. Lanchester, London.
24,772. CARBIDE HOLDERS, H. Salsbury, London.
24,773. BOTTLE SPOUT, W. B. Robatham and J. G. Rollason, Birmingham.
24,774. PORTMANTEAUS, A. C. Gurney and R. A. Sinclair, London.
24,775. GAS and other EXPLOSIVE ENGINES, T. Myers, London.

24th November, 1898.

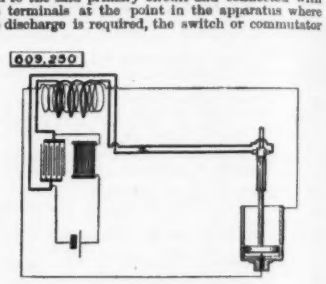
24,776. BICYCLE-DRIVING MECHANISM, E. B. Tillam and T. Whitehall, Birmingham.
24,777. EYE-GLASSES, W. A. Dixey, London.
24,778. BICYCLE CHAIN CLEANING DEVICE, H. Robinson, Keighley.
24,779. TIRES, E. C. Vaudrey, Southampton.
24,780. MERRY-GO-ROUNDS, B. Ruckemesser and K. Schufft, Glasgow.
24,781. HANDLE for DRUMS, &c., E. M. Ginders, Birkenhead.
24,782. SANITARY MANGERS for HORSES, W. Oates, Halifax.
24,783. WINDOW CLEANING DEVICES, W. and J. Jack, Glasgow.
24,784. MERCERISING WOVEN FABRICS, J. H. Wood, Manchester.
24,785. GENERATING GAS, C. J. Bailey and J. H. Nicklin, Manchester.
24,786. CASTING BUFFER HOLES in PEDESTALS, G. D. Innes, Manchester.
24,787. DETONATING SIGNAL for RAILWAYS, J. Beco, Glasgow.
24,788. LAVATORIES, R. W. McDonald, London.
24,789. CLOSETS, R. W. McDonald, London.
24,790. WINDOW SASH SUSPENDER, E. J. Barker, London.
24,791. PIPE JOINTS and COUPLINGS, W. Fewins, London.
24,792. WATER WASTE PREVENTER, S. H. Brierley, Birmingham.
24,793. OVEREDGE SEWING MACHINES, D. J. McDonald, Glasgow.
24,794. PURIFYING DIRTY and WASTE OILS, W. Evans, Manchester.
24,795. MAKING CONDUIT TUBES, C. Bollé.—(*G. Brandt, Germany.*)
24,796. SEATS, J. J. Nicholson; Barnsley.
24,797. BEER PUMPS, G. Howard and J. Smith, Barnsley.
24,798. TOBACCO PIPES, G. Lockett and C. Webb, Manchester.
24,799. WATCH PROTECTOR, E. Latham, Wratting, Cambridgeshire.
24,800. WINDOW SASH FASTENERS, H. Davies, London.
24,801. HOLDING BLINDS in POSITION, G. Larken, London.
24,802. SHIRT and COLLAR FASTENER, J. Gunning, Bournemouth.
24,803. HEATING REFRACTORY SUBSTANCES, W. Borchers, London.
24,804. PREVENTING INCRUSTATION in GENERATORS, W. Kirchner, London.
24,805. HOLDERS for SADDLES, &c., F. B. Footit, London.
24,806. BARREL TILTERS, J. Revill, London.
24,807. KNITTING MACHINES, G. A. Mitchell, London.
24,808 SUGAR CONFECTIONS, W. K. and G. S. Baker, London.
24,809 PLUGGING CUPOLA TAP-HOLES, J. W. Miller, London.
24,810. BRAIDING MACHINES, H. A. O. Weiss, London.
24 811. AUTOMATIC STIRRING APPARATUS, H. R. Phillips, London.
24,812. ELECTRICAL METERS, R. E. B. Crompton, London.
24,813. AUTOMATIC WEATHER STRIP, G. W. Mitchell, Canada.
24,814. BUTTONS, H. R. Mortell, London.
24,815. SPURS, J. Clarke and F. Humphris, London.
24,816. SCYTHES, K. Lucas and E. Lefler, Berlin.
24,817. ENVELOPES, A. Flamm, Berlin.
24,818. CONFECTIONERY, A. Jacoutot and W. K. and G. S. Baker, London.
24,819. LEAK STOPPERS for TUBING, F. Dye, London.
24,820. PEDAL CRANKS, W. O. Mosley, London.
24,821 MOUTHPIECES for TOBACCO PIPES, E. B. Watson, London.
24,822. SLIDING WINDOW SASHES, H. Callow, London.
24,823. WINDOW SASHES, H. Callow, London.
24,824. GRIDIRONS, T. E. Shepherd, London.
24,825. CLEANING FORKS, F. H. Southgate, London.
24,826. BOXES for TEA, E. H. Archer, London.
24,827. ANTI-VIBRATION WHEELS, A. F. Spencer, London.
24,828 EXPLOSIVE ENGINES T. Myers, London.
24,829. CANVAS DRIVING BELTS, T. F. Edwards, London.
24,830. COLOURING MATTERS, H. H. Lake.—(*Farbwerke Mühlheim, Germany.*)
24,831. REGENERATING EXHAUST STEAM, H. J. Farrer, London.
24,832. PACKING RINGS for PISTONS, W. Buckley, London.
24,833. SUSPENDING ELECTRIC MOTORS, S. H. Short, London.
24,834. COUPLINGS for RAILWAY CARRIAGES, S. Binkel, London.
24,835. CANDLESTICK, F. Muntzel and W. Plambeck, London.
24,836. MUD-GUARDS, C. Bourdin, London.
24,837. CURLING and WAVING HAIR, J. R. Hatmaker, London.
24,838. CURLING HAIR, J. R. Hatmaker, London.
24,839. GENERATION of MOTIVE POWER, V. Tourtier and the New Motive Power Syndicate, Limited, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

609,250. ELECTRICAL IGNITER for GAS ENGINES, *N. Tesla, New York, N.Y.—Filed February 17th, 1897.*

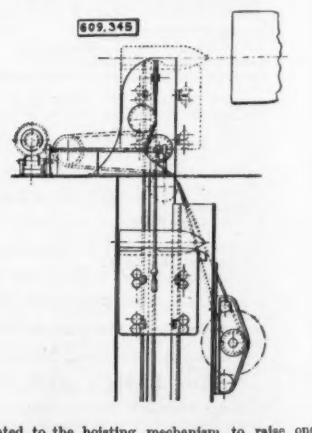
Claim.—(1) In an apparatus which depends for its operation or effect upon the production of a sudden electric discharge at a given instant, or at predetermined intervals of time, the combination with a moving part of said apparatus of a switch or commutator, a condenser a charging circuit for the same, a primary circuit through which the condenser discharges, and a secondary circuit in inductive relation to the said primary circuit and connected with the terminals at the point in the apparatus where the discharge is required, the switch or commutator



being operated by the said moving part to effect the discharge of the condenser at the proper intervals, as set forth. (2) In a gas or explosive engine of the kind described, the combination with a moving part of said engine of a circuit closer or switch controlling the charging and discharging of a condenser, separated terminals in the cylinder or explosive chamber, and a transformer through the primary of which the condenser discharges, the secondary being connected with the terminals in the cylinder, as set forth.

609,345. APPARATUS for CHARGING HEAVY BREECH-LOADING GUNS, *F. W. Hawkins, Sheffield, England. —Filed November 18th, 1897.*

Claim.—An ammunition hoist, comprising, in combination with the gun platform, a trunk or lift divided into two working ways or compartments at its lower end, guideways located on inner opposite sides of said trunk or lift and extending from top to bottom thereof, carriers slidably supported in said guideways, hoisting mechanism at the side of said trunk or lift, a series of supporting pulleys and a series of guide pulleys located at the upper portion thereof, cables oppositely wound on said hoisting mechanism and extending along said guide pulleys and over said supporting pulleys and connected to said carriers, and



operated to the hoisting mechanism to raise one carrier to a "ready" position while lowering a companion carrier to the bottom of the trunk or lift, and mechanism for raising the carriers independently from a "ready" to a charging position comprising guides supported on the gun platform, yokes slidably mounted on said guides and carrying pulleys each of which engages a cable of a carrier between a pair of guide pulleys, and winding drums mounted on said platform and having cables connected with said yokes and operating independently to move said yokes with their pulleys over said guides and thereby draw the cable engaged by each pulley to one side, substantially as described.

ON THE STEERING OF THE BICYCLE.

By G. T. McCAW, B.E.

THE complexity of the question of the steering of the cycle has, no doubt, revealed itself to the rider who has given the matter any attention. He finds at once that the speed has a preponderating influence on the steering. The intelligent rider soon learns also that the weight and size of the steering wheel have a large effect. Indeed, one frequently is told that the larger the front wheel of the bicycle the better will the machine steer—a statement which contains only a partial truth. The steering, however, is affected by other considerations not so obvious, as the wheel base and the proportion of total weight on the front wheel. The question then arises, Can a general formula be obtained which will include all the foregoing, and by which the proper design of the steering head may be determined?

It is hardly necessary to point out the necessity for correct steering: every experienced rider knows how much less is the fatigue to hands and arms of riding an easily-steered machine. It is therefore desirable that the causes which affect the question should be investigated, and, if possible, a theoretical analysis worked out, from the results of which the best design can be determined beforehand, thus avoiding the waste of time and money entailed by the alternative necessity for a series of experimental tests on the various models.

Since the straight front fork was abandoned in favour of the curved, opinions have varied as to the proper design of the latter. Each maker has his own ideas on the subject, and only in a few cases does success seem to be attained. Thus the variation of the rake—the angle which the steering head makes with the vertical—is considerable. The perpendicular distance from the centre of the front wheel on the steering axis—*i.e.*, the axis of the steering socket—is also very variable. Again, the amount of curvature of the front fork frequently exhibits a difference of opinion. Some consideration should reveal the fact that provided the rake and the perpendicular above mentioned are the same, the particular curvature has no effect on the steering, though for purposes of strength the curvature should be as continuous as possible, and ought not to change abruptly, as in some models of to-day. It is obvious that if the rake and perpendicular distance above are determined, the position of the steering axis is determined; or the axis may be fixed by finding the rake and the point where the axis cuts the line of ground contact.

The following investigation necessarily involves a rather complex analysis; the results are, however, summed up at the end for those who do not care to wade through the mathematics of the subject.

We shall assume, at the beginning of the argument, that the bicycle is moving at a uniform rate on a circular track, and that the banking is such that the surface is perpendicular to the plane of the machine. The resultant, therefore, of the weight and centrifugal force is perpendicular to the surface of the track. In what follows we shall speak of this as the "resultant," and when we speak of a rise or fall of the centre of gravity it is to be understood that the distance is measured on this resultant and not on the vertical. The following are the symbols adopted. The dimensions given are used in some examples at the end:—

W weight of machine and rider, 190 lb.
w weight of front wheel, 4 lb.
R resultant of total weight and centrifugal force.
n fraction of resultant weight on front wheel, $\frac{6}{15}$.
a radius of front wheel, 14in.
k radius of gyration of front wheel, $12\frac{5}{16}$in.
b wheel base, 44in.
v velocity on track, 10½ miles per hour = 15ft. per second.
r radius of track.
α rake of steering head.
θ angle through which the handle-bar is turned.
z the distance from point of ground contact of front wheel to point where steering axis cuts the base.
y length of perpendicular on steering axis from centre of front wheel.

The steering axis is now usually designed to cut the ground in front of the point of wheel contact. In this case a rotation of the handles will have the effect of lowering the centre of the front wheel by an amount we shall call h. Hence, when the cycle is moving round the track, the plane of the front wheel making an angle θ with the plane of the machine, the centre of gravity of machine and rider—considered as one system—will have fallen by an amount $n\,h$. The resultant tends to move the steering wheel further from the plane of the machine; its effect, however, is neutralised by the gyrostatic couple, and correct steering will be assured by equilibration of these opposing forces. We have, therefore, by the principle of work,

$$\mathrm{R} \,.\, \delta\,(n\,h) = \mathrm{K} \,.\, \delta\theta \quad . \quad . \quad . \quad \text{(A)},$$

where K is the gyrostatic couple. It will first be necessary to find h.

In Fig. 1 the steering socket is supposed held rigidly in position while the wheel is turned through an angle θ. The wheel is now raised off the ground by the amount h. If the wheel be projected back on the normal plane its figure will be an ellipse, centre O′, and the height of the horizontal tangent to this ellipse will give the required distance.

The equation of the ellipse to the axes is

$$x^2 \cos^2\theta + y^2 = a^2 \cos^2\theta.$$

The equation of the horizontal tangent P′ Y is

$$x \cos\alpha - y \sin\alpha = a\,\sqrt{1 - \sin^2\alpha \sin^2\theta}.$$

The height of O′ above the base line P Z is

$$a - y\,(1 - \cos\theta)\sin\alpha$$

Hence

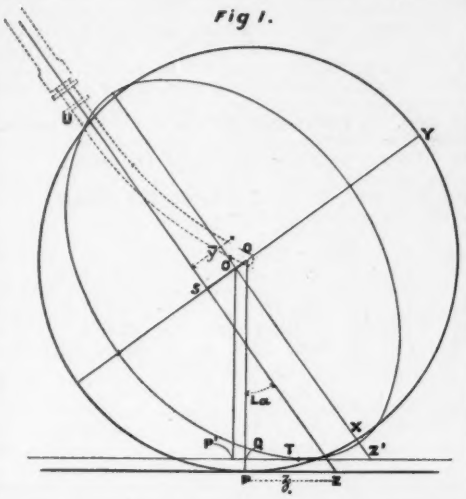
$$h = a - \bar{y} \sin\alpha\,(1 - \cos\theta) - a\,\sqrt{1 - \sin^2\alpha \sin^2\theta} \quad \text{(B)}.$$

From this equation it follows that $h = o$ when (1) $\alpha = o$, and (2) when

$$\sin\alpha = \frac{a\,y}{a^2 - (a^2 - r^2)\sin^2\frac{\theta}{2}},$$

or $\sin\alpha = \frac{y}{a}$ approximately, when θ is small. Since under these circumstances $z = o$, we have proved the

Fig 1.



following, which is, of course, otherwise evident. When the steering axis passes through the point of ground contact, h is approximately zero for small values of θ. If there were no gyrostatic action, therefore, the steering axis should intersect the lowest point of the wheel, and this is nearly the correct position when the speed of the cycle is very low.

From equation (B) the following is derived:—

$$d\,h = \frac{\sin\alpha \sin\theta\, d\,\theta}{\sqrt{1 - \sin^2\alpha \sin^2\theta}}\,[a \sin\alpha \cos\theta - y\,\sqrt{1 - \sin^2\alpha \sin^2\theta}] \quad . \quad . \quad . \quad . \quad \text{(C)}.$$

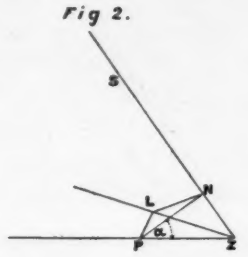
In the second place, it is necessary to find a value for K, the gyrostatic moment. If ω be the angular velocity of rotation of the fore wheel, ϕ its rate of turning round the track, or, as it is called, the angular velocity of precession, then the above quantities are connected by the following equation:—

$$\mathrm{K} = \frac{w}{g} \,.\, k^2\,\omega\,\phi \quad . \quad . \quad . \quad . \quad \text{(D)}$$

—Perry: "Spinning Tops," p. 90.

Now $\phi = \frac{v}{r}$, and r may be found as follows. Referring to Fig. 2, L Z is the trace of the front wheel as the

Fig 2.



machine travels round the track. If, then, a plane L N P be drawn perpendicular to the steering axes S Z, the angle L N P = θ. Hence when θ is small

$$\theta = \frac{\mathrm{P\,L}}{\mathrm{P\,Z}\cos\alpha} = \frac{\angle\ \mathrm{P\,Z\,L}}{\cos\alpha}.$$

Also, it is evident that $\angle$ P Z L = $\frac{b}{r}$.

Hence $\phi = \frac{v\,\theta\cos\alpha}{b}$. Also $\omega = \frac{v}{a}$. Substituting these values of ϕ and ω in equation (D),

$$\mathrm{K} = \frac{k^2}{a\,b} \cdot \frac{w\,v^2}{g} \,.\, \theta \cos\alpha \quad . \quad . \quad . \quad \text{(E)}.$$

Having thus found expressions for K and $\delta\,h$, we apply these to equation (A), which then becomes, when the increment of θ is taken infinitely small—

$$n \,.\, \mathrm{R} \,.\, \frac{\sin\alpha \sin\theta}{\sqrt{1 - \sin^2\alpha \sin^2\theta}}\,[a \sin\alpha \cos\theta - y\,\sqrt{1 - \sin^2\alpha \sin^2\theta}] = \frac{k^2}{a\,b} \cdot \frac{w\,v^2}{g} \cos\alpha \,.\, \theta \quad \text{(F)}.$$

From this equation y can be found for all values of α.

Suppose, however, that θ is very small, so that the cycle is travelling practically in a straight line, then neglecting $\sin^2\theta$ and putting $\sin\theta = \theta$ and $\cos\theta = 1$, the equation (F) becomes

$$n\,\mathrm{W} \sin\alpha\,(a \sin\alpha - y) = \frac{k^2}{a\,b} \cdot \frac{w\,v^2}{g} \,.\, \cos\alpha.$$

But $a \sin\alpha - y = z \cos\alpha$, hence

$$z = \frac{w \,.\, v^2 \,.\, k^2}{n\,\mathrm{W} \,.\, g \,.\, a\,b \sin\alpha} \quad . \quad . \quad . \quad \text{(G)}.$$

This neat result gives the value of z corresponding to any chosen rake of head, and hence the position of the steering axis is exactly determined.

In the above investigation we have neglected (1) the friction of the steering head, (2) the ground resistance to rolling, (3) the ground resistance to turning the wheel. Of these the first two need not be considered. The third, however, may not be negligible if the speed is low and the tire soft; however, as the speed increases the friction will diminish, and in the absence of experiments it is doubtful whether this resistance would appreciably affect the result at ordinary speeds with tires properly inflated. It has also been assumed that the speed is constant. Especially in the case of high gears this is not quite true; obviously, however, the machine should be designed for the average speed on the level.

We shall now discuss the practical results which this formula (G) affords. In the first place, it allows a choice of rake, but the angle of rake having been chosen, the position of the steering axis is absolutely fixed, since the formula gives a definite value for z—the distance from point of front wheel contact with base line to the point where the steering axis cuts the ground—corresponding to any chosen value of α, the angle of rake. The choice of this angle, within certain limits, depends on other considerations than the steering, such as strength, stiffness, and general convenience of design. We say within certain limits, because, suppose the angle were excessively increased so that the spring of the front forks became considerable, it is obvious that this in itself would adversely affect the steering; indeed, it may be stated generally that any diminution of strength and stiffness of the fore-carriage will militate against ease of steering, provided, of course, that the position of the axis is correct in the first instance. As an example of the influence of the question of strength in deciding the proper angle, it may be noticed that this angle should be as far as possible chosen that y—the perpendicular distance from the centre of front wheel on the steering axis—may be as small as possible, for it is evident that the greater the distance through which the centre of the front wheel is moved from the plane of the machine, the greater will be the cross strains introduced, and consequently the more will the strength be impaired. With the ordinary safety the limits above mentioned may be 18 deg. and 25 deg.

In the second place, the formula shows the great influence of speed on the steering, for it proves that z increases as the square of the velocity. Again, it demonstrates that the distance z should increase directly as the weight of the front wheel, and approximately as the radius of the same. These three results are conformable to experience. The formula, however, also proves that z should decrease as the proportion of total weight on front wheel, the wheel base, and the rake increase. These latter results, though they follow from the argument, are not so obvious to the expert rider. We shall apply this formula to a few examples.

Example 1.—Taking the case of a safety having the dimensions already given, and supposing the rake to be about 24½ deg., so that $\sin\alpha = \frac{5}{12}$, it follows that z should be 3·32in.

Example 2.—If in the same safety the speed were only eight miles an hour = 12ft. per second, the distance z would be only 2·12in.

Example 3.—If the machine were a tandem—weight of front wheel, 4½ lb.; radius of gyration, 12½in.; wheel base, 66in.; and speed, 18ft. per second (12½ miles per hour); weight on front wheel, 130 lb.—then, other things being the same, the value of z would be 1·84in.

The following table gives the values of y and z for a single safety of the dimensions stated at beginning of article, the steering angles varying from 15 deg. to 35 deg.:—

α	15°	18°	20°	22°	24°	25°	26°	28°	30°	35°
y	in. −1·53	in. +0·08	in. 1·00	in. 2·20	in. 2·60	in. 2·96	in. 3·31	in. 3·98	in. 4·61	in. 6·06
z	+5·38	4·46	4·03	3·68	3·39	3·20	3·14	2·93	2·76	2·40

In the same way tables may be formed for any speed, size or weight of wheels, weight of rider and machine, &c., and for any type of rear-driven safety or tandem bicycle. The results are also approximately true for tricycles of the Cripper type.

AMERICAN PADDLE-WHEEL STEAMERS WITH BEAM ENGINES.

No. VI.

THE frequency with which the Hudson River steamers have been lengthened has already been commented upon, and the lengthening of the New York by 30ft. in 1897, by cutting it apart amidships, and pulling the bow section ahead 30ft., to make room for a new section, was an operation of exceptional interest. The following particulars are therefore given somewhat in full, from information published in the *Scientific American*, and from drawings furnished the writer by Mr. W. D. Dickie, Superintendent of the Erie Basin Dry Docks, owned by the John N. Robins Company. The New York was taken into the dry dock at Brooklyn, and was placed upon the ordinary arrangement of keel blocks and bilge blocks. The vessel was then cut between the engine and the boilers, the hull being cut at the riveted joints, and the superstructure being cut straight across.

As the forward part was to be pulled ahead, launching ways and cradles were built under this part of the boat. The ways were 102ft. long, placed 10ft. 9in. apart in the clear, and outside of these main ways—3ft. 9in. from them—were additional ways to take the weight of the boilers. The fixed ways were of timbers 10in. deep and 14in. wide, laid upon blocking upon the floor of the dock. Guide pieces 12in. deep were spiked against the outside of these, to keep the sliding ways in place. These sliding ways were timbers, 6in. by 14in., laid flat, and connected at regular intervals by transverse timbers, 12in. by 12in., resting upon them. The contact surfaces of the fixed and sliding ways were planed and smoothed, and were

lubricated with a mixture of fish oil and tallow. The space between the transverse timbers and the hull was filled in with blocks and wedges, while at the forward end were shoring pieces and a short cradle to fit the decreasing width and the taper of the bow.

The hauling arrangements consisted of two 1⅜in. chains which were passed through the hawse holes, one on each side, at the main deck. Each chain was wrapped around four sets of bitts, and secured to a fifth bitt, all along the edge of the main deck. In front of the stem these chains were wrapped together, and the end of each was attached to a five-sheave block. At the head of the dock, two four-sheave blocks were attached each to a 1⅜in. stud chain, these two anchor chains being led back through one of the buildings and secured to a horizontal timber, 12in. by 12in., lying on the ground and bearing against the building. Each five-sheave block was connected to one of the four-sheave blocks by a 5in. manilla rope, and the free end of each rope, returning from the five-sheave block, was led to a steam winch having two cylinders. One of these winches had cylinders 6in. by 10in., and the other had cylinders 6in. by 9in. The steam pressure was 70 lb. per square inch.

Everything being ready, the wedges in the blocking were driven home, raising the forward section of the ship until its weight was carried entirely by the ways. This weight was about 350 tons. A signal was then given and the winches were started simultaneously at a slow speed, the superintendent, Mr. W. D. Dickie, standing on the floor of the dock, under the bow, and directing the men at the winches, until the cut part of the boat reached a mark on the floor of the dock, 30ft. from its original position. The work of hauling occupied 5½ min. The two sections of the vessel were then lined up with piano wire, but the hauling had been done so carefully that the forward section had only to be jacked up $\frac{3}{16}$in. on one side, and the stem to be jacked over 1in.

The fifteen new steel frames had already been made, and the work of putting them in was at once commenced. The framing and plating is similar to that originally used, except that two additional keelsons were put in. These are of ⅜in. plate, and are spaced about 16ft. apart. The cutting out of the rivets in the hull was commenced at 11 a.m., November 11th, 1897, and was completed the same night. The ways were completed by 3.30 p.m. next day, and the forward section was moved, and the new frames secured in place by noon of November 13th. The working time was 17½ hours.

It is estimated that the lengthening will not lessen the speed, as the boat will now trim better, especially with heavy loads, when the passengers crowd to the forward decks, and the boat has a tendency to go too much by the head. In fact, this additional length gives a surplus buoyancy of about 5½in., giving the feathering buckets of the paddle-wheels a better dip with less immersion. It is therefore expected that the wheels will make a greater number of revolutions per minute.

The view—Fig. 30—gives a very good idea of the construction of this ship. In the middle are the new frames of the hull, already set, and the men are passing another frame down the side of the dry dock. To the right is the forward section of the ship, with the main deck "guards" extending out beyond the hull, and supported by inclined braces or struts from the hull frames. Above this is the saloon deck, the open ends of which are boarded up, while the stairways and the companion hatches on the promenade decks are covered in with canvas. Forward of the two companion hatches may be seen the bottoms of the three smokestacks, each with its short escape pipe in front, and forward of this again is the pilot-house, which is entered by a stairway from the promenade deck. The after section of the vessel, at the left of the view, shows the main and saloon decks with their narrow promenades or gangways outside, the latter protected by a canvas awning, while above is the open promenade deck. It will be noted that all the windows are large, and are fitted with sliding sunshades or blinds of polished wood.

No article on the steamers of the Hudson River would be complete without reference to the Mary Powell, a steamer of wide-spread fame for speed. This celebrated steamer has been styled the "Queen of the Hudson" on account of its speed. It is a day boat, running between New York and Rondout, a distance of about 92 miles. It was built in 1861, the hull by M. S. Allison, and the engine and boilers by Fletcher, Harrison, and Company. It was rebuilt in 1874, while the hull was entirely rebuilt by Ward, Stanton, and Company, in 1884, at which time a new engine cylinder, 72in. by 144in., was put in to replace the original cylinder 62in. by 144in. At the first rebuilding the vessel was lengthened about 40ft., but in the second rebuilding no further alterations were made, the lines of the wooden hull being strictly preserved.

Originally it was 260ft. long, 34ft. 6in. beam, 64ft. wide over the guards, and 10ft. 3in. deep, with a draught of 6ft. As rebuilt in 1874, it was 286ft. long on the waterline and 300ft. long over all. It has a gross tonnage of 983 and a net tonnage of 877 tons. The cylinder is 72in. by 144in., and the engine developes 3000-horse power when running under forced draught. The wheels are 31ft. diameter, with twenty-six buckets 10ft. 6in. long and 1ft. 9in. wide, the dip being 3ft. 6in. The two boilers are placed outside the superstructure, on the main deck guards, overhanging the water, aft of the paddle-boxes. The boiler pressure is 45 lb. A donkey boiler is also provided, and for fire protection there is a complete system of piping, kept constantly charged by a Delameter steam pump.

The hull has very graceful lines, and is strengthened by timber hog-frame trusses, as well as by iron rods passing up from the ends and over pole masts. Above the main deck is a superstructure, with saloon deck and promenade deck, each of which extends from the stern to a point about half way between the paddle-boxes and the bow. The dining room is aft, on the main deck. Fig. 31 presents an excellent view of this noted steamer.

The Mary Powell has a speed record of twenty-five miles per hour. On August 7th, 1874, it ran from New York to Poughkeepsie, seventy-five miles, in 3 h. 39½ min., or 3 h. 19 min. actual running time, giving an average speed of nearly twenty-three miles per hour, exclusive of stops. In 1881 it made the trip of ninety-two miles, from New York to Rondout, in 4 h. 12 min.—3.33 p.m. to 7.45 p.m.—including eight stops or landings. This gives an average speed of twenty-two miles per hour, including stops. If we deduct twenty-five minutes for the stops—which is a small allowance in view of the reduction of speed on approaching and leaving the landings—we have a running time of 3 h. 41 min., or an actual running speed of about twenty-five miles per hour.

The following interesting and complete particulars of the dimensions of the Mary Powell, and the performance of its engines, are taken from a report made by Mr. Theron Skeel about 1878, and given in Appleton's "Encyclopædia of Applied Mechanics"—

Ship.

Length on water-line	286ft.
Length over all	294ft.
Beam at water-line	34ft. 3in.
Width over all (over guards)	64ft.
Depth of hold	9ft.
Height from main deck to promenade deck	10ft.
Height from promenade deck to upper deck	8ft.
Draught of water at mean load of passengers and coal	6ft.
Midship section, estimated	200 sq. ft.
Projected area of surface resisting head wind	2000 sq. ft.
Displacement, estimated	28,000 cu. ft.
Length of trip	Five hours and return
Average number of passengers	250
Personnel (exclusive of steward's department): One captain, two engineers, four firemen, four deck hands, two pilots, one clerk, one baggage master; total	15

Engine.

Diameter of cylinder	6ft.
Stroke of piston	12ft.
Piston-rod, diameter	8in.
Air pump, diameter	3ft. 4in.
,, stroke	5ft. 2in.
Shaft, diameter	1ft. 3in.
Journal, diameter	1ft. 3⅜in.
,, length	1ft. 5in.
Crank-pin, diameter	8⅜in.
,, length	10⅜in.
Paddle-wheels, diameter over tips of buckets	31ft.
Buckets, length	10ft. 6in.
,, width	1ft. 6in.
,, number to each wheel	26
Greatest immersion of outer edge of bucket at mean draught	3ft. 6in.
Displacement of piston per revolution	676 cu. ft.
Clearance at both ends of cylinder	25 cu. ft.
Diameter of steam and exhaust valve openings in steam chest	1ft. 2⅞in.

Boilers.—Two steel, dimensions of each.

Length over all	26ft.
Cylindrical shell, length	16ft. 1in.
,, ,, diameter	10ft.
Fire-box, length	9ft.
,, width	11ft.
Steam drum, diameter	5ft. 10in.
,, ,, height	12ft.
Steam chimney, diameter	4ft. 2in.
,, ,, sectional area	25 sq. ft.
Furnaces, number	2
,, length	8ft.
,, width	4ft. 10in.
Direct flues, length	9ft. 1in.
,, ,, diameter	2 of 9in., 2 of 14in., 6 of 16in.
Tubes, diameter outside	4½in.
Smokestacks (two), diameter	4ft. 6in.
,, height above grate	68ft.
Grate surface (two boilers)	152 sq. ft.
Heating surface (two boilers)	2660 sq. ft.
Superheating surface (two boilers)	340 sq. ft.
Flues, area	23¼ sq. ft.
Tubes, area	17¼ sq. ft.

Record of Performance for 1877.

Total number of miles run	15,300
Hourly quantities—	
Speed in miles (5280ft)	19·3
Revolutions	1306
Pounds of coal consumed	5970
,, ,, combustible (ashes 16⅔ per cent.)	4870
,, ,, coal consumed per square foot of grate surface	39·3
Pounds of combustible consumed per square foot of grate surface	32·8
Pounds of coal per square foot of heating surface	2·25
Pounds of combustible per square foot of heating surface	1·88
Temperatures—	
Atmosphere	70 deg.
Hot well	120 deg.
Feed-water	120 deg.
Chimney gas	Zinc melts
Pressures—	
Steam, pounds per square inch above atmosphere	28
Vacuum, inches of mercury	25
Initial pressure, pounds per square inch above zero	40
Pressure at cut-off, pounds per square inch above zero	31·2
Pressure at end of stroke, pounds per square inch above zero	16·4
Mean back pressure	5·6
Pressure at end of cushion, pounds per square inch above zero	40
Mean total pressure, pounds per square inch above zero	29·94
Mean indicated pressure, pounds per square inch	24·34
Mean net pressure, pounds per square inch (friction 1·5)	22·84
Point of cut-off, fraction of stroke	0·47
Point where cushion commences, fraction of stroke	0·80
Power—	
Total horse-power	1899
Indicated horse-power	1540
Net horse-power	1446
Pounds of steam used per hour	42,000
,, steam used per total horse-power per hour	22·1
,, steam used per indicated horse-power per hour	27·3
,, steam used per net horse-power per hour	28·9
,, coal used per total horse-power per hour	3·14
,, coal used per indicated horse-power per hour	3·87
,, coal used per net horse-power per hour	4·13
,, water per pound of coal, from 120 deg.	7·0
,, water per pound of coal, from 212 deg.	7·8
,, water per pound of combustible from 120 deg	8·2
,, water per pound of combustible from 212 deg	9·1
,, water per square foot of heating surface per hour	14

Results of Performance for Two Years.

	1876.		1877.
Number of observations	12	...	27
Running time, Newburgh to New York, or return, minutes	187·5	...	182
Distance run in above time, miles	60	...	60
Revolutions per round trip from Rondout to New York and return	13,100	...	12,190
Distance as above, miles	90	...	90

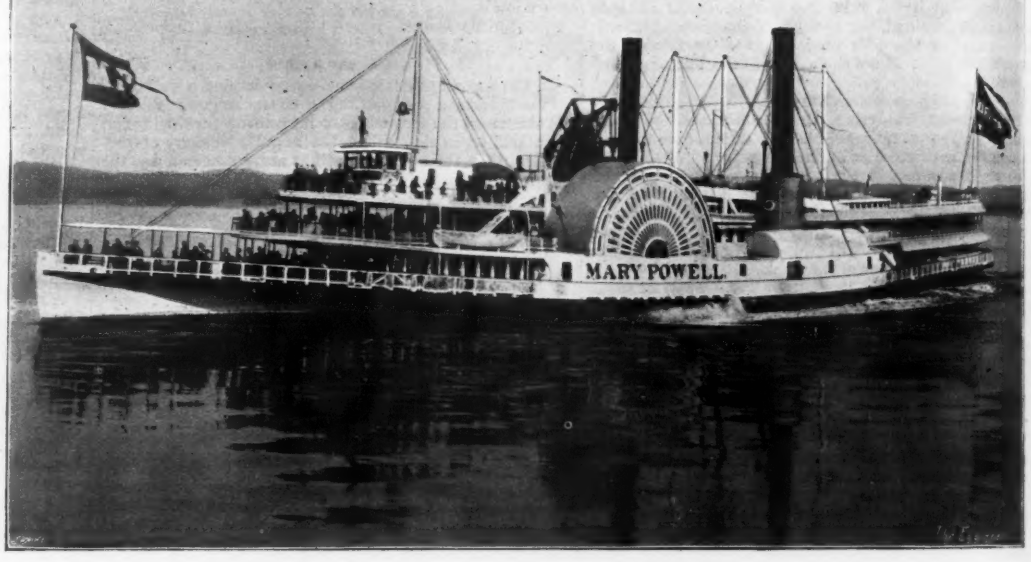


Fig. 31—THE HUDSON RIVER STEAMER MARY POWELL

Revolutions per minute, Newburgh to New York, or return	21·30	...	21·77
Speed in miles per hour, Newburgh to New York, or return	19·20	...	19·80
Coal per round trip, gross tons...	22·85	...	24·25
Coal per revolution, pounds	4·57	...	4·37
Slip of wheels, per cent. (calculated for centre of paddle)	14·50	...	11·90
Revolutions from Newburgh to New York, or return	4007	...	3963
Revolutions per mile from Newburgh to New York, or return...	66·8	...	66
Revolutions per mile per round trip	72·9	...	67·2

LITERATURE.

The Cofferdam Process for Piers: Practical Examples from Actual Work. By CHARLES EVAN FOWLER, Member American Society of Civil Engineers, Bridge Engineer. First edition. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

THE separate classes into which all descriptions of cofferdams may be divided depend upon the presence of several different conditions, which are by no means numerous. In all instances the object to be attained is the same, and consists in an attempt to reach a solid, durable foundation by the best and most economical means at the disposal of the engineer. The principal varying conditions which demand the employment of one or other form of cofferdam are the depth of water, the depth at which the foundation bed must be laid beneath the natural bed of the river, lake, or stream in which the permanent erection is to rest, and the existence of currents, and whether they be feeble or strong. Other points to which consideration must be given are the nature of the strata through which the cofferdam must be driven or sunk, and the character of the foundation bed itself when it is reached. Passing over the historical notice, and the account of some of the primitive and earlier types of cofferdams recorded in Article I., we are introduced in the second to the subjects "Construction, Practice, and Crib Cofferdams." Obviously the simplest case to be treated is that in which the water is shallow, and there is very little or no current. A simple structure of earth, clay, or clay mixed with a small proportion of sand will suffice for the exigencies of all such situations. The thickness of the top of the dam need rarely exceed 6ft., and its height above water 3ft., but the slope of the sides may range 2 to 1 to 3 to 1, according to the consistency of the material of which they are composed. It is this variable quantity which is the chief factor in restricting the employment of earthen cofferdams within their present narrow limits.

Articles II., III., and IV. are devoted to the description of actual examples of cofferdams, their construction, different designs and forms, methods of excavating and dredging, and stopping leaks—an operation which frequently entails a serious amount of trouble, accompanied with much vexatious delay. The various kinds of pile drivers are also enumerated, including the well-known Nasmyth steam hammers. The author draws attention to two cases in which failure occurred. One was due to the excavation of an overlying porous strata not being carried out so completely and effectually as it should have been by the proper dredging operations, and we quite concur in the remark, "This is perhaps the most frequent source of failure of a well-constructed cofferdam." A second example of failure is very suggestive of the influence the form of a cofferdam may have upon its ultimate strength, and carries a warning lesson with it. The dam was circular in shape, and the main piles, consisting of whole balks, were driven down close together until they reached the rock. They were all hooked or tied together at the top by boiler iron about 4ft. in width, and the idea was that, while this iron band would suffice to hold them together at their upper extremity, the thick *couche* of mud overlying the rock would be equally efficacious at their lower end. The event, however, proved the fallacy of the idea. After the first dam—for there were three trials undertaken—had been pumped dry, it suddenly collapsed in less than an hour afterwards. In the second and third experiments the iron boiler-plate hoop was replaced by a strong steel rail, and, in addition, the third specimen was strongly reinforced by a number of tie rods radiating from the centre to the circumference. In spite, however, of all extra precautions, both failed by collapsing before the pumping of them out was accomplished. These three failures in succession led to the abandonment of the circular form, which was perhaps a little premature. It is quite possible that had the structure been strengthened at regular intervals lower down by iron bands or rails, until at least the superincumbent layer of mud had been reached, it would have withstood successfully the pressure upon it.

There are three general cases selected by writers on the design and construction of cofferdams. The first includes single dams, in which the piles are regarded as beams fixed at one end and free at the other—as cantilevers, in fact—and subjected to the action of a uniformly varying load, which may be conveniently treated as an equivalent resultant load acting at the centre of gravity. Under the second category may be classed similar dams, but with the upper extremities of the piles supported by struts fixed at right angles to them. These are exactly in the position of beams supported at both ends, and calculations respecting them can be made on that assumption. The third case is that in which the dam is strutted both at the top and about half down its height. It may be considered also as a beam supported at both ends, and although the distribution of the load is somewhat different from what obtains in the other two instances, yet practically it may be taken as uniform, and applied also at the same point. Simple formulæ are laid down in the text for determining the thickness of the piling, the strength of the waling pieces, and other timbers, and some useful diagrams appended to illustrate the different examples. The author observes that when two rows of sheet piling are to be driven to form a puddle chamber, and there is no internal bracing, the common rule "is to make the width of the puddle chamber equal to the height above ground up to 10ft." When the height exceeds 10ft., add one-third of the excess height to 10ft. for the width. This is Rankine's rule, and is generally accepted by the authors of text-books and treatises on the subject, and probably by professors and others. It does not appear that it is founded upon any particularly trustworthy data, nor is there, so far as we are aware, any accurate method of ascertaining what the proper thickness should be. A certain minimum thickness is indispensable to render the dam water-tight, which, however, varies from about 2ft. to 5ft. Numerous existing examples of cofferdams constructed of sheet piling are described and illustrated in Chapter VI., and Mr. Fowler endorses a statement recently made in our columns by remarking that "the growing scarcity of timber will doubtless lead to the use of metal at some time in the future to replace sheet piling for cofferdams." In the two succeeding "Articles," cylinders, caissons, piers, and cofferdams of metal, including those of the Forth Bridge, are treated of. Some of these were used as cofferdams and some were not, and in the majority of instances they constituted part of the permanent structure. The contents of these articles include a full account of the different types of pumps used from early times.

It may be perhaps fairly asked, is there any reason for describing and illustrating pumps which "are, however, little used." There is just a slight *soupçon* of the trade circular in a portion of the matter in Article VIII. The views of the author are correct in his comparison of the relative merits of the reciprocating and the centrifugal pump, from which he concludes that the latter is essentially a low-lift machine. While not professing to impart any information of an original character, the volume of Mr. Fowler will save those who have an object in perusing it, much valuable time, and greatly facilitate the labour of research.

Elasticität und Festigkeit. Von C. BACH, Professor des Maschinen-Ingenieurwesens an der K. Technischen Hochschule Stuttgart. Berlin: Julius Springer. 1898.

THIS is a very complete treatise on the testing of materials, and on the associated mathematical theories. It is worth the careful consideration of modern engineers in guiding them to the most appropriate designs, and in warning them against the misapplication of material, in excess as well as in defect, both faults being equally capable of conducing to weakness of structure. A notable feature of the work consists of the elaborate photographic diagrams taken of the actual pieces experimented upon, and showing by ruled lines on the surface the deformation of the substance anterior to its destruction by fracture. Testing machines are now plentiful in engineering laboratories, and the present work should form a necessary accompaniment in supplying the requisite theory, and in showing what has already been realised with careful, well-chosen experiments. Without avoiding any essential difficulties, the author has kept his mathematical treatment condensed within reasonable limits. The argument is, however, occasionally difficult to follow where he has been compelled to make some additional assumption to get out of a difficulty, and has not given his readers sufficient warning of the change of front in his argument. According to the note on page 232, the modification of Euler's formulæ for the buckling load of a column, which Rankine attributes to Gordon, had been given some time previously by Navier and Schwarz. In connection with Euler's theory, it is well to investigate the effect of what is called *ganelissement* in French, due to lack of torsional rigidity in a structure, like the too scientifically-designed panel of a bridge, destined to resist stresses in a vertical plane only, and apt to twist and cockle under very slight excentric loading. But perhaps this will extend beyond the scope of the present treatise, which is intended to cover the work and experiments carried out in an engineering laboratory. These experiments are of a totally different character to those niggling minute operations prescribed in the so-called physical laboratory, which must tend to cramp the mind of any engineering student, except an electrical one. The theory of helical springs is treated in an elegant manner on page 57, followed by the discussion of the stresses in thick cylinders and spheres, as required in the design of modern artillery. The author makes a courageous attack on the theoretically intractable problem of the elasticity of plane unstayed surfaces, such as cylinder covers, and by some judicious assumptions arrives at working formulæ of practical utility. Altogether, the work will perform a useful service, if only in showing our young engineers the careful training in habit of mind of their German rivals, whose increasing competition in our own and foreign markets will show that it is not safe to rest on the laurels of an older school of engineering.

Ordinary Differential Equations. By JAMES MORRIS PAGE, Adjunct Professor of Pure Mathematics in the University of Virginia. London: Macmillan and Co. 1897.

THE author has set himself the laudable task of presenting, in an elementary manner to a beginner, the theory of the infinitesimal transformation of differential equations, invented by Professor Sophus Lie, formerly of Leipzig, but recently called to the chair of mathematics of his native country in Christiania, where he carries on the traditions inaugurated by his immortal countryman Abel.

After two short introductory chapters on the ordinary theory, the author starts in Chapter III. on Lie's theory. Ever since the discovery of the infinitesimal calculus, the integration of differential equations has been one of the weightiest problems that have attracted the attention of mathematicians. It is not possible to develope a method of integration for all differential equations, but it was found possible to give theories of integration for certain classes of these equations. All these special theories of integration were regarded by the older mathematicians as different theories based upon separate mathematical methods.

But Lie has shown that it is possible to subordinate all these older theories of integration to a general method; he showed that the older methods were applicable only to such differential equations as admit of known infinitesimal transformations. In this way it became possible to derive all the older theories from a common source, and at the same time to develope a wider point of view for the general theory of differential equation.

The expression "infinitesimal transformation" is ignored as yet in our treatises, so the writer, who had the privilege of hearing in 1886-7 Professor Lie's first lectures on this subject at the University of Leipzig, has done well in popularising the ideas in the present treatise. The engineer may ask how such abstract theory may concern him, to be told that some of the most important differential equations of the dynamics of vibration—say, of the mast of a steamer, or of an electric light installation—would be intractable without the assistance of Lie's researches.

Lectures on the Geometry of Position. Part I. By THEODOR REYE, Professor of Mathematics in the University of Strasburg. Translated and edited by THOMAS F. HOLGATE, M.A., Ph.D., Professor of Applied Mathematics in North-Western University. London: Macmillan and Co., Limited. 1898.

THIS is a subject which, under the name of descriptive geometry, does not flourish in this country, although cultivated to a great extent in Germany. Perhaps Professor Henrici's pupils at the Central Institution are the only followers of the method among us. It requires the combination of abstract and advanced geometrical study with the skill of the draughtsman on the drawing-board, two antagonistic qualities with us. The geometer will rarely take the trouble to use rules and compasses to make a diagram, while the draughtsman is kept at work in a strictly utilitarian spirit. The present volume of 240 pages forms only Part I. We are reminded of the lavish luxuriance of some treatises on graphical statics. We suppose both these subjects have the fascinating facility of, say, trilinears in pure mathematics. The "free use of pencil and paper" is, however, beginning to gain ground with us, as seen from Professor Hele Shaw's British Association "Report," 1892, and the present treatise will give an unlimited supply of interesting exercises.

Five-Plane Logarithmic and Trigonometric Tables. By J. W. NICHOLSON, A.M., LL.D, Professor of Mathematics, Louisiana State University, and Agricultural and Mechanical College. London: Macmillan and Co., Limited. 1898.

FOUR-FIGURE logarithms are quite long enough for the ordinary work of the engineer, and these can generally be cut down to the three-figure logarithms of the slide rule, considering the uncertainty of the physical data on which he has to work. These tables have been prepared chiefly for use in solving the exercises in the author's text-book on trigonometry, where, as in very accurate surveying and geodesy, the angles are supposed to be read to the decimal of a minute. The second part of the book is a collection of the elements of plane and spherical trigonometry, such as would be useful to surveyors on a large and small scale.

SHORT NOTICES.

Hazell's Annual for 1899: A Cyclopædic Record of Men and Topics of the Day. Revised to November 22nd, 1898. Edited by W. Palmer, B.A. (Lond.) London: Hazell, Watson, and Viney, Limited. 1899. Price 3s. 6d.—This useful encyclopædia of the principal events of past years and record of arrangements recently made, or of events due to occur shortly, maintains its position by the careful bringing up to date of the quantity of information it contains.

Trigonometry at a Glance: A Graphic Demonstration of the Various Functions. For Class Use and Private Study. By George W. Usill, M.I.C.E., and Frederick J. Browne, C.E. London: George Philip and Son. Price 2s. net.—This "book" consists of two stout cards hinged together, each measuring 10in. by 7½in. On one, besides other figures, there is a circle marked with the trigonometric function, having one end of a loose travelling arm attached at its centre, so that it can be moved up into any radial position. On the other card are printed the functions of angles of 30 deg. and 60 deg., and a transparent triangle of celluloid centred at the corner of a quadrant, about which it can be rotated to show the complementary functions. The cards should be useful to an elementary class with the help of a competent instructor.

BOOKS RECEIVED.

The London University Guide for the Year 1898-9. London: Published at the Univ. Corr. Coll. Press.

Michael Faraday: His Life and Work. By Silvanus P. Thompson, D.Sc., F.R.S. London: Cassell and Co., Limited. 1898. Price 5s.

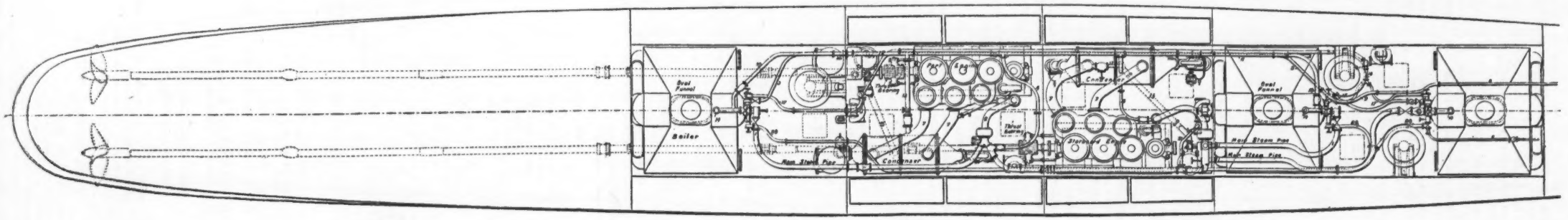
The Witwatersrand Goldfields: Banket and Mining Practice. By S. J. Truscott. London: Macmillan and Co., Limited. 1898. Price 30s. net.

ALMANACS, DIARIES, &c.

WE have to acknowledge the receipt of a beautifully printed calendar in a leather case, from Messrs. Ismay, Imrie, and Co. There are twelve cards, with two graceful designs by Mr. Linley Samborn, and photogravure productions of views connected with the White Star Line.

IT is announced in the American papers that the United States have secured a site for a coaling station on the Chiriqui lagoon, which is a large inlet from the Caribbean Sea, on the Eastern Coast of Costa Rica. This lagoon is a natural harbour lying midway between Greytown, the probable starting point for the Nicaragua Canal, and Colon, the Atlantic opening for the Panama Canal.

TORPEDO BOATS Nos. 24 to 35, FOR THE UNITED STATES NAVY



TORPEDO BOATS FOR THE UNITED STATES NAVY.

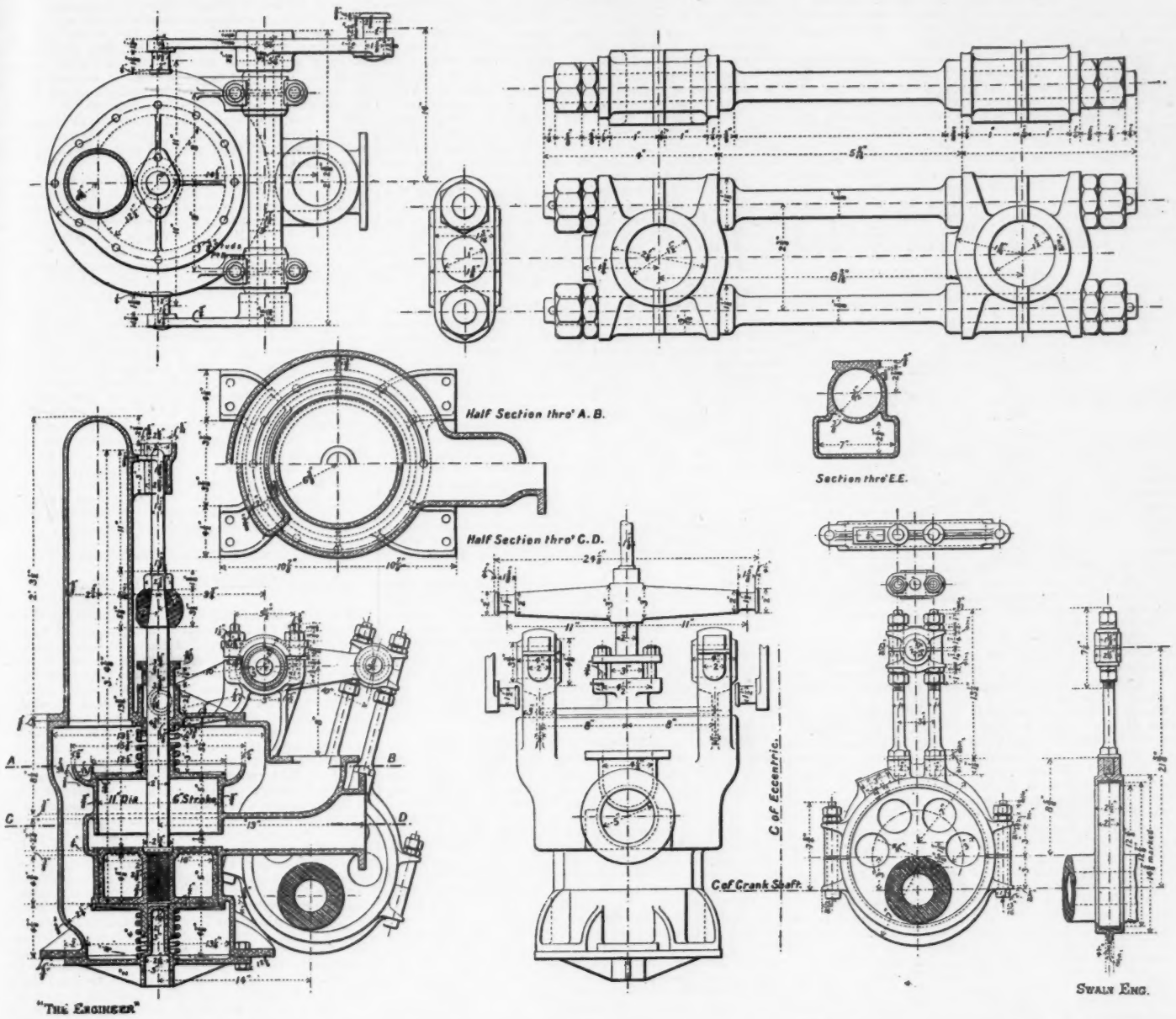
In our impression for October 21st we published an illustrated description of certain torpedo boat destroyers, to be added to the United States navy. We now illustrate certain parts of twelve torpedo boats, which are to be constructed at once, reserving other drawings for another issue. These boats will be of 150 to 170 tons displacement on the trial trip, including an allowance of 9 tons for ordnance, 10 tons for coal, and 8 tons for crew, stores, &c. Each will be propelled by twin screws, driven by vertical engines in separate compartments, steam being supplied by water-tube boilers, and the bunkers having a capacity for at least 40 tons of coal. There will be two conning towers, the forward one built of ½in. nickel steel. The battery will comprise three rapid-firing guns, and on the deck there will be mounted three 15ft. torpedo tubes, with torpedoes, and space must be provided below for storing two additional torpedoes and five war heads. The total weight of all ordnance and ammunition will be 13 tons. There is to be accommodation for twenty-six men and three officers, with provisions for twenty days. The builders are to guarantee a speed of at least 26 miles per hour, and if the boat does not attain a minimum speed of 25 knots per hour on a run of two hours, it will not be accepted. Each boat is to cost not more than £34,000, and is to be completed in twelve months. They are to be of good freeboard and seagoing qualities, and capable of operating at high speed in a moderate seaway. They will be classed as Nos. 24 to 35, and are rated for a speed of 26 knots per hour on a displacement of 165 tons. The main propelling engines —see illustration, page 563—will be of the vertical, inverted, direct-acting, triple-expansion type, with four cylinders, developing about 3000 indicated-horse power at 350 revolutions per minute. They will be placed in separate compartments, with the high-pressure cylinders forward, and low-pressure cylinders aft. The high-pressure cylinder will be 14in. in diameter; intermediate cylinder, 22in.; and the low-pressure cylinders, 25½in. diameter. The stroke will he 18in. Each cylinder will have a single piston valve, operated by the Stephenson link motion. Each main piston will have one piston-rod, with a crosshead working in a slipper guide.

The engine bed-plates will be of cast steel, supported on forged steel keelson plates, and the framing will consist of vertical forged steel columns. There will be two condensers, made of composition and sheet brass, each having a cooling surface of 1240 square feet, measured on the outside of the tubes through which the water passes. Each main engine will have a double-acting air pump, driven from the shaft, and each condenser will have a circulating pump of the centrifugal type.

The crank shafts will be hollow, and made in one section. The shafts, piston-rods, valve rods, connecting and excentric rods, and working parts generally will be of forged nickel steel, The propellers will be right and left, made of manganese bronze. Steam will be supplied by three water-tube boilers, built for a working pressure of 250 lb., having a total grate surface of at least 137 square feet, and a total heating surface of at least 7544 square feet. Each boiler will have its own funnel, and a blower for forced draught. Two of the boilers will be in a compartment forward of the engines, and the third in a compartment abaft the engines. The pump equipment will include two main feed pumps, one auxiliary feed pump, and one fire and bilge pump, each having a capacity of 147 gallons per minute at a piston speed of 100ft. per minute. The weight of all machinery, boilers, auxiliaries, condensers, pipes, stores, and spare parts, pipe, &c., and water in the boilers is not to exceed 79·745 tons.

Each crank shaft will be 6¾in. diameter, and 10ft. 4½in. long, with crank pins 6¾in. by 9in., a 4in. hole being bored through each shaft and pin. The cranks of the high and intermediate-pressure cylinders will be opposite each other, as will be those of the two low-pressure

TORPEDO BOATS FOR THE UNITED STATES NAVY—AIR PUMP



cylinders, the two former making an angle of 90 deg. with the two latter. The sequence will then be high-pressure, first low-pressure, intermediate, and second low-pressure. The thrust shafts will be 6in. diameter, with twelve collars ½in. wide, 8½in. diameter, 1in. apart. Each shaft will have a 3½in. axial hole. The propeller shafts will be 6in. diameter, cased with composition ⅜in. thick at the bearings, this casing being water-tight, shrunk and pinned on. The stern tube shafts will also be 6in. diameter, with 3½in. axial holes, and similarly cased. These will be supported by a stern bracket on each side of the hull. The thrust bearings will be cast steel blocks, having collar spaces lined with white metal.

The boilers are to be tested before being set by being filled with water and heated until a pressure of 360 lb. is obtained.

These torpedo boats will, we are sure, attract much attention from all torpedo boat designers in this country; for both in hull and machinery they widely depart from general practice here. They are from the designs of Mr. George W. Melville, engineer-in-chief to the U.S. Navy, and are 175ft. in length by 17ft. beam, 165 tons displacement, with twin-screw engines of 3000-I.H.P., to give them a speed of 26 knots. The two engine-rooms are amidships, one ahead of the other, separated by a water-tight bulkhead. Forward of these is a boiler-room containing two water-tube boilers, the stokehold between these two boilers being only 10ft. long, which seems very close quarters for the firemen to work in, especially as overhead in it there are two horizontal fans with their engines. We may remark that it is difficult to get two fans to run at even approximately the same speed, and waste of labour and power is involved in attempting to do so. Abaft the engines is another similar boiler with one horizontal fan. The length taken up by this arrangement is, of course, very considerable, and it is cut out of the roomiest part of the boat. Not only is the general arrangement quite novel, but the engines themselves are full of novel, or, at least, unusual practice. The bed-plate girders containing the main bearings are only united to each other longitudinally by the hull of the vessel, there being no fore-and-aft girders, as usual in English practice. The engines are, however, well stiffened in both senses by diagonal bracing. We shall illustrate them later.

RAILWAY EXHIBITS AT SOUTH KENSINGTON.

THE important collection at the South Kensington Museum of drawings, models, and relics connected with the early history of railways steadily grows in extent and interest. It is to be regretted that the space allotted to it scarcely expands in proportion, so that the old tendency to overcrowding is still rather too noticeable, especially as regards the specimens of early permanent way.

Amongst recent additions to the Museum are three more sheets of the admirable "wash" drawings of old locomotives, prepared from details supplied partly by the builders of the engines represented and partly by Mr. C. E. Stretton, of Leicester. With such authorities as their sanction, these drawings may fairly be regarded as authentic memorials of the engines as they were originally built; in fact, they form the only accessible records of many of them.

The first of these three additional sheets of diagrams represents ten engines built between 1833 and 1853, by Messrs. Charles Tayleur and Co., some under that name and some under their present title of The Vulcan Foundry Company, of Newton-le-Willows, Lancashire. Two of these engines were built for American lines, and have leading bogies, conclusively proving that the system of a movable four-wheeled frame was perfectly understood in this country as long ago as 1833. Both engines have single driving wheels. The firm's twenty-fifth engine, built in 1836 for the Greenwich Railway, is also shown; it was named Royal William after it left the works, and was a very small four-wheeled machine, with inside cylinders only 10in. by 16in., and 5ft. single drivers placed in front of the fire-box. A special curiosity is No. 316, built in 1848 for the Shrewsbury and Chester, now Great Western, Railway. This is also a four-wheeler, with both axles under the boiler, but the wheels are coupled and driven by an intermediate crank shaft, the cylinders being inside. The arrangement never became popular, though W. Bridges Adams, Crampton, and others used it from time to time, generally with single drivers. The next sheet of diagrams represents various examples of Messrs. R. Stephenson and Co.'s practice from 1825 to 1851, beginning with the first Stockton and Darlington engine, Locomotion, and ending with Crampton's 6ft. single Folkestone, built for the South-Eastern Railway, and shown at the Great Exhibition of 1851. This also has an intermediate crank shaft. The two first engines built with direct action instead of beam or other motion, Messrs. Stephenson's Experiment for the Stockton and Darlington, and America for the Delaware and Hudson line, 1826 and 1828, are shown on this very valuable record, as well as another bogie engine of 1833 for America. Within the last few weeks a sheet of similar diagrams of early Great Western engines has been added to the collection. They are of especial interest now that the broad gauge is no more, and comprise the North Star—this is also on the Stephenson sheet—Vulcan, Lion, Ajax, Fire Fly, Iron Duke, and Lalla Rookh, the dates ranging from 1837 to 1855. Of the whole lot shown on the collection of sheets, the Iron Duke is the only one whose tender is given. It seems a pity the tenders are not shown, if only for the sake of completeness, but no doubt in many cases there was no accurate record of their design, and certainly in some cases they were built locally to save the cost of carriage from the engine builders. This was done in several instances in the early days of the Liverpool and Manchester line. The diagram of the Iron Duke shows the engine without flanges to the driving wheels, just as built in 1847. The wheels seem very slight, but an examination of the Lord of the Isles at Earl's Court last year shows that they really were so. In fact, all the early broad-gauge rolling stock had wheels of decidedly light scantling. Lalla Rookh was one of the ten 7ft. coupled eight-wheeled engines built by Messrs. R. Stephenson and Co.

A photograph has lately been added of a special curiosity in the shape of the Tredegar engine, No. 16 of Messrs. Stephenson and Co.'s first set of books, 1829. It ran on the Sirhowy Railway from Tredegar Ironworks to Newport (Mon.), and was not finally disused till 1882. Latterly it only conveyed slag out to the cinder heaps at Tredegar. It is a six-coupled engine, with outside inclined cylinders, 10½in. by 20in., working the leading wheels, and has an internally-fired boiler, without a fire-box of the usual type. No doubt it had a single-flue boiler originally, but it has been much altered. It is not stated what has become of this most curious relic of old days.

Two more models of locomotives, both on a small scale, have been added. One of these represents a somewhat unusual type, viz., a six-wheeled single engine with outside bearings, and a round fire-box of Bury's pattern. By means of compressed air the driving wheels can be made to revolve, as is the case with certain other model locomotives close by. The model in question is beautifully made, mostly of brass, and represents a passenger engine of about 1837, with inside cylinders 12in. by 18in., and 5½ft. drivers. It was built by Mr. J. Dawson, superintendent at Southampton of the London and South-Western Railway. The other model is of particular interest, having been made by Timothy Hackworth, and retained in his family till quite recently. It is a design constructed to show how an engine built by Wilson in 1826 for the Stockton and Darlington would work if rebuilt with six wheels coupled and two vertical cylinders driving the trailing wheels. The engine was so re-built, and as the Royal George, No. 5, worked from 1827 to 1842, drawing 130 tons on the level at five miles an hour.

Some fine photographs of the standard passenger and goods tank engines of the Taff Vale Railway, as built at Cardiff by Mr. T. Harry Riches, are shown, as well as models and photographs of the coal tips on the same line at Cardiff

and Penarth. In these the ingenious Thomas-Bachelor box for lowering the coal straight down into the hold of the ship, instead of running it down a shoot and breaking it up, is exhibited. The Midland Railway Company have a model of the vacuum brake, as fitted to their coaching stock, with Mr. T. Clayton's improvements. The brake cylinder is shown swinging upon trunnions, in order to save the space which would otherwise be occupied by a connecting-rod between the piston-rod and the brake lever.

Amongst minor curiosities is a cotton handkerchief printed with twelve views of the trains, stations, and scenery on the Liverpool and Manchester Railway, about 1831. In the centre is an engine of the Samson class, four-wheeled goods, and a description underneath in English, French, and German. In these days of acute competition the idea might be revived, and handkerchiefs with views of the scenery down the line might prove a good speculation at shops near the terminus. Several models of various types of cattle trucks, designed for enabling the cattle to feed on the journey, are to be found at South Kensington. Much ingenuity has been expended upon this subject, but with little benefit, as the animals are usually not at all inclined to avail themselves of any benefits in the direction of dining cars adapted to their requirements.

It is understood that the Museum authorities have already considerably more railway objects of interest than they have room to exhibit simultaneously. They consequently adopt, to some extent, the system of changing the minor exhibits from time to time—not a very satisfactory plan, but the best possible under the circumstances.

THE MINERAL WEALTH OF THE PHILIPPINE ISLANDS.

FROM a mineral point of view the Americans have apparently very good cause to be satisfied with their new acquisition, the Philippine Islands. The four million pounds which are to be paid to Spain as a sort of compensation, simply represent the value, as estimated by the Americans, of the various public works contained in the islands, and have no reference whatever to the actual value of the islands as producers of revenue. The conquerors will now obtain the benefit of the resources of the islands, and with intelligent management and the well-known energetic direction of the Americans, a very considerable income may reasonably be anticipated. The islands appear to abound in minerals of all kinds, from gold down to oil, though at present silver is not cited as being present.

Mr. George F. Beeker, of the United States Geological Survey, has recently visited the Philippine Islands, and from a report which he has sent in it would appear that coal is to be found, and is at present being mined very largely throughout the Archipelago.

The coal is said to be analogous to the Japanese coal, and to that of Washington, but not to Welsh or Pennsylvania coals, which means to say that it is a highly carbonised lignite or soft bituminous coal. Such coal usually contains a considerable amount of combined water—as much as from 8 to 18 per cent. is not uncommon in lignites such as this—which would render it a bad coal for carrying, but evidently it can be used locally in preference to higher-priced English or other imported coal for a large number of purposes. Unfortunately for the United States it is not, so far as can be judged, at present likely to be of use for marine work. This would have been a magnificent thing for them had it been so, but though for this purpose they will no doubt have to import all they need, the native coal should if properly worked prove of great pecuniary value. Of its kind the quality is high, and on account of its being widely distributed and the seams thick, it should be easily and cheaply mined. There is no information to hand at present as to at what depth it is found, nor as to what special difficulties, if any, are met with in obtaining it. There are, moreover, no details as to its heating value, which presumably is low, like that of the other lignites of the world. Even supposing it to be as low as, say, 4000 British thermal units, which is low even for lignite, it should be easily able to compete with any foreign coal for use on the islands themselves, where labour is most probably exceedingly cheap.

It is urged in disfavour of such coals that they are liable to contain much injurious foreign matter, such as sulphur, and that they are hurtful to boiler plates. There is no evidence at present that sulphur is present to an injurious extent, and before expressing any opinion we should like to see some analyses. It is not unlikely, however, that it is very largely present, considering the volcanic nature of the islands.

Natural gas is said to exist together with the coal in places. This is by no means an unmixed blessing, but may still be turned to good account, and oil seems to be present also, though in what quantity it is not stated. It would seem to be similar to the American oil, and in places it is highly charged with paraffin.

Gold, copper, iron, and lead seem to be the principal metals which are known to exist, at present at all events, though we should be very surprised to hear that there are no others. Gold, however, appears to be present in a large number of places, principally in alluvial deposits, whether in existing streams or in watercourses now destitute of water. It would therefore be readily obtained, no crushing being needed. Copper is reported from many of the islands, and probably is of fairly frequent occurrence, while iron ore is said to exist in abundance in four, at all events, of the islands; and if this is easily obtainable it should turn out to be of great commercial value. Lead has already been mined to some extent, and no doubt as the islands become more and more American other mineral resources will be brought to light, and we may be sure that our cousins across the water will make the best possible use of them.

EAST LONDON WATER SUPPLY.

WE are glad to hear that the East London Water Company has at length, after a period extending over more than three months of intermittent supply, been able to resume constant supply in Poplar, Limehouse, Millwall, Ratcliff, Bromley, Loughton, Chingford, Chigwell, and Buckhurst Hill, and that before the end of this week it is expected that the whole of the district served by the company will receive its due amount. We congratulate the company on the termination of what must have been to it a period of anxiety. We stated the other day that it was extremely difficult to obtain any trustworthy information as to the exact state of affairs; and even now it is not easy to get at the whole of the facts of the case. Bit by bit, however, we are learning more about it, Without doubt the watershed of the Lea has this year undergone a period of drought, worse than anything previously recorded. Moreover, the smallness of the total actual rainfall has been accentuated by the way in which it came, namely, in small quantities at a time, and at long intervals. Hence many a small shower fell on ground which simply received it on its dried surface, whence it evaporated, and never reached the river at all. The average flow of water in the river Lea during the months June to October inclusive of this year never exceeded 31·6 per cent. of the average flow, and during September and October it was only 5 to 7 per cent. respectively of the average. This average, moreover, is not one got up for the occasion by the company itself; it has not been concocted and brought forward by the authorities as an excuse in full for deficiencies, but it is the average prepared from careful records made by the Conservancy Board of the river Lea. These records extend over a period of forty-seven years. The previous driest year had been 1874, and when we add that the lowest average flow during the worst month of that year was a trifle over 37 per cent. of the average, and that for the corresponding period of this year the flow in the river only reached 7 per cent. of the average, it will be seen that we are by no means exaggerating when we say that the conditions this year have been phenomenal.

So much, at all events, can be said for the East London Water Company, that it has had great difficulties to contend with, whatever its shortcomings may have been. No doubt, too, the company has had to pay dearly before overcoming these difficulties. The failure of the river necessitated extra pumping—pumping which, with the river in its normal condition, would hardly have been necessary. Then, though no figures are at present available, it is not to be supposed that the East London Company can have got connections made with the other water companies for nothing. Four of these assisted during the crisis. In the case of three of them, the Southwark and Vauxhall, the Kent and the Grand Junction Companies, connections were made by means of mains. Some of these operations rendered necessary some pieces of engineering. Of course, they all cost money, and naturally enough the water obtained through them will have had to be paid for, as well as for that which the New River Company allowed to flow down the river past its intake.

We cannot leave this subject without a word or two upon the action of the London County Council with regard to this company. We have heard many hard things said about it lately, but is it entirely to blame? Is it not true that on all possible occasions the London County Council has opposed not only extension of storage capacity but also of supply? Surely on such an important subject as water supply, a thing of absolute need not only for a healthy life, but for life itself, the companies should be assisted rather than hindered in their desire to render their position beyond chance of breakdown.

One thing which has gone a great way to increase the difficulty has been the doing away with cisterns. We mentioned this in August last. No doubt the sanitary authorities had cause for the action they took. No doubt they have found difficulty in making the inhabitants of certain districts of East London keep their cisterns clean, and when they found this impossible have ordered their removal. They could not—though perhaps they ought to have done so—have realised the possible consequences of such an act, or we venture to think they would have found some other way out of their difficulty; and they certainly would not have permitted the "cheap house" builder, so well known in the East End, to take his cue from their action and build his houses with no cisterns at all. We do not think it too much to say that had every house in the East London Company's district had its cistern, there would have been no "famine." We know of houses in the district which, being provided with cisterns, have had an ample supply of water during the whole of the time of scarcity, while near neighbours, with no cisterns, have been in want. We repeat that which we said in August last, namely, that every builder should be compelled to put a dirt and dust-proof cistern in every house he builds. Uncleanliness, the great objection to their use, would thus be removed, and a reserve of water be always at hand, should it at any time become necessary to discontinue for a short period the constant supply. We learn with pleasure that the East London Water Company is seeking in Parliament, not only for increased powers in connection with storage and supply, but also for the compulsory restitution of cisterns. We sincerely trust that it may obtain all it seeks, and that as a consequence we may hear no more of water famines in East London.

NEW TRAINS FOR THE METROPOLITAN RAILWAY COMPANY.

THE Metropolitan Railway Company have recently put on their line a series of new and specially-designed trains that have been built for them by the Ashbury Railway Carriage and Iron Company, Limited, of Manchester, and which are examples of what can be done in the way of making travelling on city and suburban lines, or over short distances, comfortable. The drawings we give to-day as a supplement show the general and detailed arrangements, which have been carried out by Mr. Thomas S. Raney, the company's carriage superintendent. The general dimensions are as follows:—Total length over buffers, 244ft. 1½in.; length of bodies, 39ft. 6in.; width of bodies, 8ft. 3in.; centres of buffers from rails, 3ft. 5in.; centres of bogies, 25ft.; wheel base of bogies, 7ft.; and height inside from floor to roof at centre, 7ft. 2in.

The trains are fitted with the automatic vacuum brake, and consist each of six carriages mounted on four-wheeled bogies, a van being at either end. They are close coupled, and will run as block trains, the vans only being provided with the usual couplings. The bogies and underframes are built entirely of steel, the former of patent flanged plates and the latter of channels. The weight is transmitted from the bolster through a set of helical springs to the swing beam, and thence to the bogie frame. The side bearing springs are of the laminated type, with india-rubber auxiliaries. The bodies of the vehicles are of varnished teak-wood picked out on the mouldings, with gold bands and vermillion lines, the whole train presenting an elegant, well-finished appearance as it stands on the rails.

Two special features of these trains are the heating apparatus and the electric lighting, the former being on the storage principle. A pipe connected to the engine runs underneath the carriages the entire length of the train, having suitable couplings between the vehicles. From this pipe, branches run to the storage heaters, one of which is placed in each compartment. The heater consists of a cylinder containing a non-freezing mixture, and has a steam jacket surrounding it; steam from the engine raises the temperature of the mixture, which afterwards gradually radiates the heat into the compartment. The electric lighting is on Stone's system, by which each carriage is lighted independently, two sets of accumulators and a dynamo being suspended beneath the carriage, the latter being driven from one of the axles in such a way that, no matter what the speed of the train may be, after a certain determined point has been reached, the amount of current passing to the lamps is constant, whilst a regulator placed outside at one end of each carriage switches on the whole or half of the light, as may be desired. The lighting of all the carriages, whether first, second, or third class, is of equal efficiency, each compartment being provided with a couple of 8-candle power lamps.

In their general arrangements and fittings these trains are also quite up to date in meeting modern requirements. The third-class compartments are upholstered in rep, with lace and cord to match, whilst the roof is covered with papier mache decorated with floral and line design, and polished teak fittings, oak-grained woodwork, with fibre mat on the floor are also noteworthy features. The second-class compartments are upholstered in crimson velvet, with buttoned backs and seats and elbow rests under the windows; the doors are padded, and the floor covered with linoleum, a rug being placed beneath the seats bearing the company's monogram. The roof and sides are of papier maché, finished in gold, with a gilt cornice running round the compartment, and the woodwork fittings are of polished mahogany. The upholstering of the first-class is of figured rose-coloured Bagdad moquette finished with silk lace and cord; elbow rests, which when not required may be pushed flush into the back, divide the seats, and all the metallic fittings of the first class are nickel-plated. The woodwork is polished walnut and sycamore with gilt edging, and the roof is of decorated lincrusta, with polished walnut and gilt mouldings. Balanced spring blinds are fitted to all the windows throughout the train, and each compartment is ventilated by means of two "torpedo" air extractors. The sides and floors of the carriages are packed with hair felt to deaden the noise of travelling.

ELECTRIC LIGHTING.

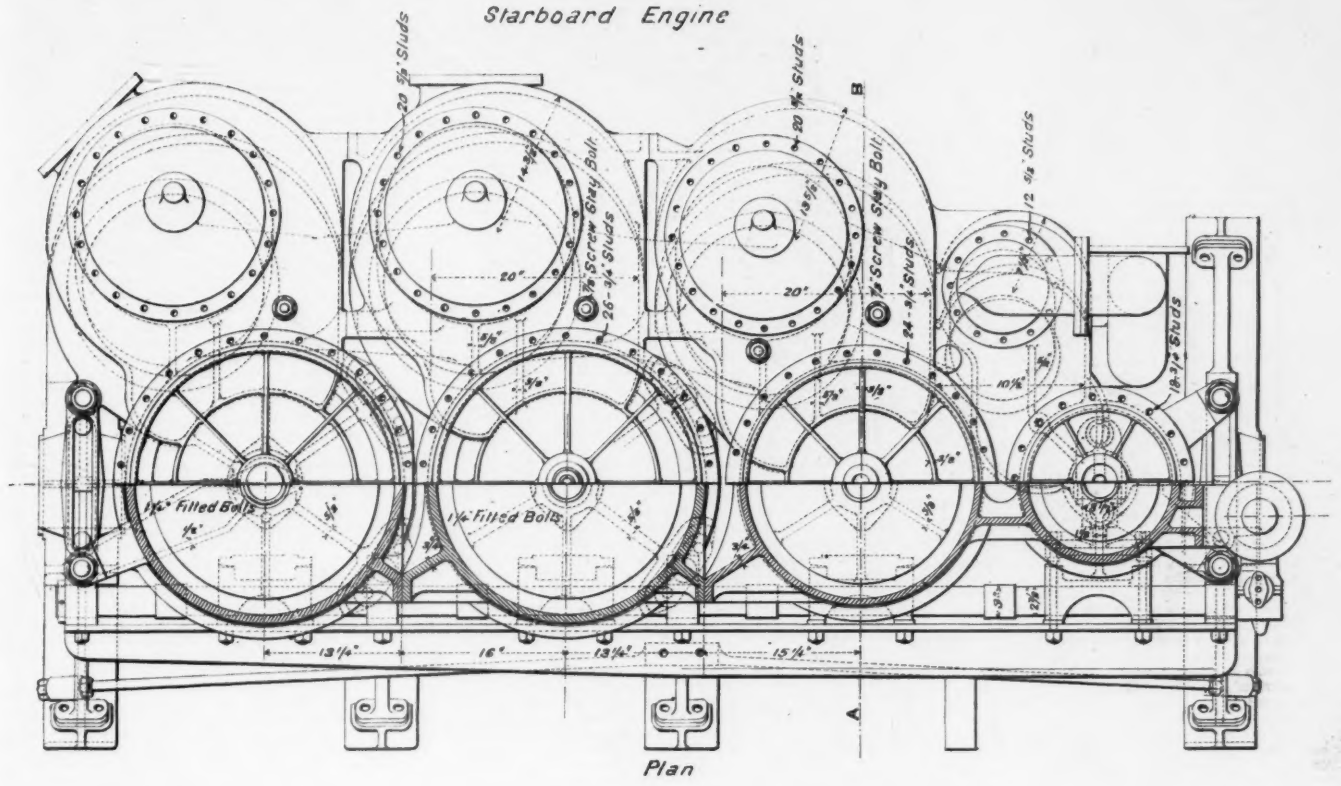
IT may be remembered that a few months ago the Select Committee of the House of Commons appointed to consider the question of the supply of electrical energy presented a series of recommendations, one of which was in favour of powers being granted in certain cases to electric light companies to supply electrical energy in areas distant from the district in which the generating station is situated. The report of the Select Committee embodying the recommendations was presented too late for the consideration of Parliament in the past session, and hence it may not unreasonably be concluded that until the Government has had an opportunity of deliberating upon the subject, the suggestions made by the Committee will remain in a state of abeyance. In the meantime, two or three companies have given notice of their intention to apply for powers in accordance with the terms of the recommendation above referred to, whilst one company has already been making strenuous efforts in order to take advantage of the recommendation of the Select Committee before Parliament has thought fit to decide whether the object aimed at shall become legally operative. The company in question—the County of London and Brush Provincial Electric Lighting Company—has been desirous of laying mains from its generating station at Wandsworth across a portion of Lambeth, for the purpose of supplying electrical energy in the district of Camberwell. But the London County Council, whose permission was sought to carry the mains through the districts in question, declined to give sanction to the proposals on the grounds that such a course would lead to great inconvenience at the time of purchase by the local authority, and that the Vestry of Lambeth had no power to grant the company's application to lay mains through a portion of that district. In view of this opposition the company not unnaturally appealed to the Board of Trade as the higher authority, and the result of the appeal was communicated to the London County Council last week in a report submitted by the Highways Committee. It appears from this report that the award of the Board of Trade is in favour of the company, in so far as the works are concerned that are proposed to be carried out within the areas of supply authorised by the Provisional Orders possessed by the company, but excluding any part of the district of Lambeth where the company has no statutory powers. The award of the Board of Trade is, however, coupled with a condition that will doubtless cause considerable surprise. The condition is that the company shall give a written undertaking to the Board that it will, if and when required by the Board, provide a suitable and sufficient generating station within the areas of supply authorised by the following orders:—The Camberwell Electric Lighting Order, 1896; the St. Olave's Order, 1895; the Southwark Order, 1892; and the St. Saviour's Order, 1896, for the supply of electrical energy in those districts. It will be obvious from this decision that the Board of Trade has entirely ignored, as perhaps it is entitled to do, the recommendations of the Select Committee in regard to the supply of electrical energy from a generating station in one district to a distant locality through an intervening area where lighting powers could not be exercised. At the same time it is impossible entirely to dismiss the suspicion that the Board of Trade is very largely consulting the wishes of the London County Council to the detriment of the company, although the latter would have been well advised not to have pressed the point in question before Parliament had had an opportunity of deciding whether to adopt or reject the recommendations of the Select Committee.

ASSOCIATION OF MECHANICAL ENGINEERS.—The annual meeting of the Birmingham Association of Mechanical Engineers was held on Saturday evening at the Grand Hotel, Colmore-row, and there was a large attendance of members and friends. The business included the election of president for the ensuing year. Mr. T. Bernard Hall, in moving the re-election of Mr. J. Cox, for the third year in succession, remarked that his ardent interest in all that affected the welfare of the association, and his endeavours to raise the association to the high level it had attained, were worthy of their sincerest thanks. Mr. Deakin seconded the resolution, which was carried unanimously. Mr. J. J. Innis was re-elected vice-president. Messrs. G. Conaty, W. J. Talbot, H. W. Ward, and T. Judge were appointed members of the council. The President said he was pleased to be able to announce another gift of valuable books to their library from Mr. W. M. Ward.

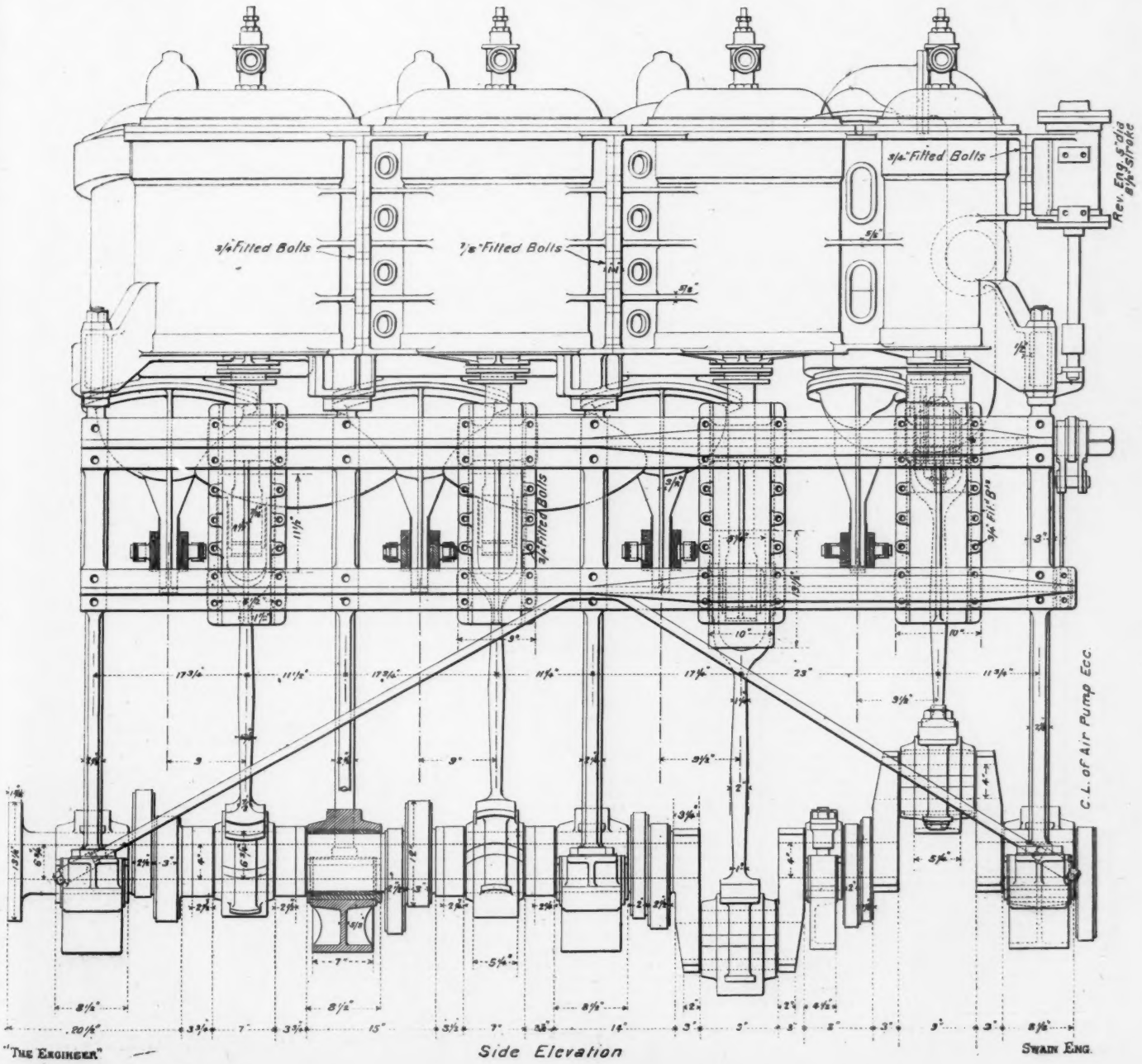
TORPEDO BOATS FOR THE UNITED STATES NAVY—ENGINES

(For description see page 561)

Starboard Engine



Plan



"THE ENGINEER" Side Elevation SWAIN ENG.

THE MORBID ANATOMY OF IRON AND STEEL SHIPS.*

By Mr. S. J. P. THEARLE, Principal Surveyor to Lloyd's Register of Shipping, at Newcastle-on-Tyne.

VERY recently you have had a lecture delivered to you in this room upon the subject of "Failures." I was not present to hear that lecture, nor am I aware which were the particular failures about which you were spoken to, but I do know that the art of ship construction has been evolved through as substantial a series of failures as any art with which I am acquainted. Not, however, as a rule, by absolute failures, but rather by many partial ones in regard to the particular qualities which have been sought to be attained. By "trial and error" has ship construction, for the most part, been developed, and through the experience gained from failures has each sure advance been made. It is about ships built of steel and iron that I wish to speak to you to-night, and about what is to be learnt from an examination of the diseases to which they are found to be liable. And here let me remark that the title chosen for this paper is a phrase which originated, I believe, with the late William Denny, and it has been adopted by me because it so aptly describes the purport of what I have to say.

The inspection of iron and steel vessels when in course of construction, has undoubtedly a highly educative value in the programme of your studies, but a persistent examination of existing vessels as they come under repair in dry dock or on slipways would be productive of even still more instructive results. In the one case you see the applied results of accumulated experience, but in the other you have presented to you the data itself upon which further evolutionary changes will be based. When examining a vessel about to be repaired you would observe symptoms of weakness being displayed here, indications of unduly rapid decay there, and in many shapes and forms you would be assured that the best known to the builder of that ship was yet short of being the best attainable. Few indeed, are the works of man's hands in which possibilities of improvement are not speedily manifested when they are applied to the purposes for which they are designed. Although the art of shipbuilding in iron is now about fifty years of age, and although mild steel has been in very general use for about fifteen years of that period, yet we are still discovering faults in our newest vessels and still making improvements in their construction. This is partly due to the fact that both steam and sailing vessels are every year being built of larger dimensions than we have hitherto been accustomed to, and with the increase in size there is an attendant augmentation in the stresses to which they are subjected. It is also partly due to the opportunity which the greater lapse of time affords us for observing the relative durabilities of iron and steel at different positions in the vessels' hulls. Time is, indeed, always an important factor in determining the extent and accuracy of our knowledge regarding natural phenomena. "He who lives longest sees most."

So long as vessels were being built of wood, every succeeding decade witnessed great advances in their construction, both in regard to the questions of structural strength and material durability. Never before had wooden ships been built so strongly, and never before were they found to be so free from early decay as at the time when they were displaced by vessels of iron. And so we may reasonably except that the construction of steel vessels will continue to make advances in all the particulars which render them less liable to wear, tear, and decay until some other material comes to take the place of steel as iron took that of wood. Whether or not such a replacement will ever occur I am unable to say, but it would be both unscientific and unwise to deny the possibility. Considering, then, the sailing ship and steamer built wholly or for the most part of mild steel, and of wrought iron where mild steel is not used, let us study for a short time the morbid appearances which are presented when they come under the ship repairer's scalpel and dissecting knife. At the same time let us endeavour to find out to what causes these appearances may be properly attributed and how they may be remedied or cured.

In so doing I propose to classify iron and steel ship diseases under two general heads, namely:—First, diseases of constructional weakness; secondly, diseases of material decay.

First, then consider the diseases of constructional weakness. A ship is a floating structure for the safe conveyance of cargoes, and must be primarily studied as such. But, in addition, she has to be grounded upon blocks in a dry dock from time to time, and hence must not only be strong enough as a floating structure when loaded, but also strong enough for enduring shoring upon blocks in a dry dock when unloaded. Moreover, she must not only be able to endure the structural stresses due to rolling and heaving movements when in a seaway, but also the local stresses due to the blows and buffetings of individual waves and masses of water. Hence constructional weakness includes both structural and local weaknesses. Instances of each of these are occasionally seen in surveying vessels coming under repair.

To range completely over the whole gamut of observation would be manifestly impossible in the limits of time at our disposal this evening. We must therefore be content with the results of but a few anatomical studies grouped under the headings I have indicated.

The substitution of steel for iron in shipbuilding was attended with other results than the mere reduction of weight in the materials necessary for obtaining the requisite structural strength. The chief object sought for in using the stronger metal was doubtless a diminished weight of hull and a corresponding increase in the cargo-carrying capability of the ship, and for this advantage in freight-earning a heavy extra price was paid at first for the steel as compared with that paid for iron. As, of course, you well know, that difference in price has wholly disappeared, and mild steel is now as cheap as wrought iron. But, as I have said, something more was gained than mere freight-earning by the change. The steel vessel is safer than one built of iron. Stresses which break iron plates only bend steel plates; stresses which break iron ships only distort those of steel. And consequently steel ships remain afloat and carry passengers and cargo into port under conditions which would cause the total loss of ships built of iron. At first, this quality seemed to make steel vessels unpopular with underwriters, and this was chiefly due to a singular instance in which a disaster to a steel vessel proved to be more costly to her underwriters than would have been the case had she been of iron. A new steel sailing ship was being towed in ballast to her loading port, and being insufficiently ballasted, she capsized and sank in shallow water near the shore. Steps were at once taken to raise her by passing chain slings under her keel and attaching them at low water to pontoons, which as the tide rose lifted the vessel off the bottom and enabled her to be towed into still shallower water. Now, through some carelessness in carrying out this simple process, the stresses upon the chains were not evenly distributed, and had the vessel been built of iron the chains would have torn some of her iron plating. Being, however, of steel, the plates yielded and bent, while at the same time the whole structure of the vessel became twisted, so that she lost her symmetry of form and had no longer both sides alike. Had she been built of iron the repairs would have been comparatively costless, as the renewal of a few broken plates would have restored her to her former condition. But as the case stood, the owners refused to take the ship from the underwriters until they had made her once more of a symmetrical form. To do this was practically impossible, and so the owners got a new ship and the underwriters recouped themselves so far as possible by selling the first one to a purchaser who was content to sail a ship not perfectly symmetrical in form which he was able to buy cheaply. This accident gave steel ship risks a bad name for a short time, but it very soon became evident to underwriters that "one swallow does not make a summer," and that with steel vessels they had to pay for small damages which would often have been total losses if the vessels had been built of iron. Over and above this consideration is the greater one—namely, that human life is saved which would otherwise have been sacrificed. Both as regards structural and local forms of weakness the morbid conditions observable in steel vessels are fewer and less serious than in those built of iron.

In estimating the intensity of stress on the upper works of a vessel it has been very usual to treat the midship section as the cross section of a loaded beam. You are no doubt familiar with the method whereby the equivalent girder is determined and the maximum bending moment and shearing stress calculated under extreme conditions, such as when supported on the crest or in the hollow of a wave of the vessel's length. Now, in this interesting and in many respects valuable calculation, you will remember that all iron and steel decks, shell plating, inner bottom, &c., are as it were condensed or squeezed so as to form the horizontal and vertical members of an equivalent girder, and the intensity of stress, either extensive or compressive, is determined upon the assumption that the horizontally and vertically-arranged materials in the vessel's hull behave under extension and compression just as the parts of this so-called equivalent girder would. Now, I have no desire to say one word in disparagement of such calculations, which are useful in affording comparative values. But, as an absolute indication of what takes place in the upper works of a vessel steaming among long waves, they are misleading, and the ships themselves show this to be the case.

Deck plating is sometimes torn from hatchway to gunwale without the sheer strake showing any distress, and side plating is torn or the butts of same started without the adjacent deck plating appearing to be concerned in the trouble. A moment's consideration shows why this should be the case. How big a gap do you think would be torn in the upper edge of a sheer strake before the adjacent deck plating would be bent sufficiently to be in tension? Remember the sheer in the deck when thinking this matter out for yourselves. And then, again, how much cross racking would a deck endure before receiving succour from the shell plating? These are the questions which ships answer when under the ship doctor's hands. Their every failure and defect indicates that the primary function of an iron or steel deck is to resist racking stresses, while the duty of the shell plating is to deal primarily with vertical bending moments. Only in their association one with the other as mutual stiffeners and supports does either take a share in doing the essential work of the other. The stringer plate stiffens the sheer strake and helps to keep it from flinching, and the sheer strake, in return, does as much for the stringer. But the upper deck stringer and plating of a ship have not a duty strictly analogous to that of the upper member of an I section beam, and this is notably the case when the sheer strake extends above the deck. For in that condition the upper edge of sheer strake may be ruptured without the deck plating being perceptibly bent. An interesting case illustrating what I am endeavouring to show you came under my notice some time ago. A sheer strake was wounded by the presence of a number of circular lighting and ventilating scuttles, besides having the ordinary relatively weak places at its butt connections. And yet when under a severe hogging stress the sheer strake was ruptured at where a solid half round iron moulding on the upper edge was butted. So you will see that such a simple break in the continuity of strength on its upper edge as was afforded by a 3in. solid cope iron was sufficient to cause failure in the sheer strake to take place at that point. Moreover, the fracture avoided the butts of the sheer strake, and the holes cut for side lights, notwithstanding that one of these latter was only a short distance away. No injury was sustained by the stringer plate, although the vertical flange of the gunwale bar was torn, and the horizontal flange a little bent.

In another vessel, recently come off a stormy Atlantic voyage, the upper deck plating was torn from the corners of a cargo hatchway nearly to the sides of the vessel without a movement being visible in a butt of the side plating. This hatchway was nearly, although not quite, at the middle of the length, but at midships there was a larger opening for machinery, the plating at the corners of which was not torn. Now, why this apparent eccentricity in the tear? Of course there was a reason for it, and one had not to seek far for that reason. Closely adjacent to the tear was a transverse water-tight bulkhead, which contributed an element of stiffness to the plating alongside it. Had the bulkhead not been there distortion would probably have resulted without fracture. But the local stiffness prevented distortion by the racking stresses operating on the deck, and consequently fracture resulted. This does not show such bulkheads to be elements of weakness, but rather the contrary. What it shows is the necessity for seeking the maintenance of continuity of resistance to stresses. The corners of the wide hatchway should properly have been secured with doubling plates—a precaution which is always desirable, and especially so when the large opening is closely adjacent to a stiff transverse bulkhead. Regarding the fracture to the sheer strake, there can be no doubt that the vessel in question was structurally weak, or the sheer strake would not have torn at all, either at the butt of a cope iron moulding or elsewhere. But that the rupture should have occurred at such a place shows how important it is to maintain not only general strength, but continuity of strength of the upper part of the side plating of a vessel. One of the commonest experiences when examining steamers as they come under survey is to find the bulwarks torn at the extremities of a bridge house. It is true that the tendency to such fracturing is aggravated by the frequent presence of water ports and holes, for mooring purposes at those parts of the bulwarks; but in vessels with no bridge houses at all, bulwarks do not tear, either at the ports or anywhere else. It is the sudden break in the continuity of strength in the side plating at the extremities of the bridge house which causes the trouble and necessitates our making the bulwarks much thicker there than elsewhere, in order to avoid it. But a bridge house is not a source of weakness on that account; on the contrary, a bridge house extending over a fairly long portion of the vessel's length is a valuable element of longitudinal strength, provided it be properly constructed. The tendency of recent years is to more and more utilise for structural purposes an erection which was at first designed to serve other uses. Indeed, in vessels of large size and of extra proportions of length to depth, the bridge house covering at least half the midship length is now considered essential to her structural efficiency.

But our study of the morbid conditions of steamers has told us more than that.

I remember cases in which bridge houses were fitted without any regard to their structural uses, but simply on account of the passenger accommodation they afforded, and the protection they gave to the engine and boiler spaces; they were not any more substantial structures than such services necessitated. But what was the consequence? Being the upper member of a deep girder throughout the portion of the vessel's length over which it extended, such a bridge house was necessarily subjected to severe tensile and compressive stresses, when the vessel was pitching and ascending in a seaway, and having very little plating on its beams, the saloons and cabins beneath could not be kept water-tight. Everywhere in this light superstructure annoying and damaging leaks were continually being experienced, which no caulking of the wood deck with oakum could keep out. Two courses were open to the owners, either to rebuild the structures and make them equal to resisting the stresses which their position in the vessel rendered them liable to, or else to cut them in two across the deck and fit a sliding water-tight joint which would allow of movement without admitting water. The latter was the alternative adopted and the trouble ended.

But this remedy, although suitable in this particular case is yet an unusual one. Good constructors seek to make all the components of a vessel of structural value, whatever may be the primary reason for their presence. And so bridge houses are now-a-days in most cases built in such a way as not only to serve their original purpose in the economy of the vessel's design, but also to take up their share of the stresses she has to endure, and render the whole structure the more efficient by their presence. It is not unusual to reduce the thickness of the sheer strake or even dispense with a doubling to the sheer straked within the limits of the bridge house, by using the material thus saved in thickening the bridge side-plating, especially at its upper strake. In such cases the sheer strake is, of course, always doubled at the bridge ends to avoid discontinuity of strength thereat. And here it is desirable to note one other manifestation which present practice is seeking to obviate. It will be evident to you that while the maximum bending moment is experienced at about the centre of a vessel's length, and therefore at about the middle of the length of the bridge house, the maximum shearing stresses on the bridge side plating will be towards its extremities. Hence, while the tendency to rupture the bridge sheer strake, or to open its butts, is at about the middle of its length, the tendency to shear the rivets in the landings of the bridge side plating is greatest at its extremities. This is often shown to be the case in actual experience. Bridge side plating was, until very recently, connected by single-riveted edge joints, but the number of cases in which the riveting of the edges has been found started and loose at the ends of the bridge showed conclusively what scientific reasoning might have predicted would happen. It is now usual to double-rivet these landings for, at all events, some 12ft. to 20ft. from each end of the bridge, and to treble rivet the butts of the bridge sheer strake throughout. To render a bridge house an efficient structural factor in a vessel it must, of course, have a plated deck, for it is of no use providing against one set of simple stresses without at the same time providing against all. Indeed, in a seaway, when a vessel is pitching, rolling and labouring in all directions in rapid succession, it is only by the complete interaction of all her parts that efficient resistance can be offered to the many and varying stresses being set up.

In the limits of time at our disposal this evening it is impossible to do more than glance at a few of the morbid conditions presented by different parts of vessels when they come under survey. Among those which are due to overwork as distinguished from the presence of disease, may be classed the various phenomena of butt movement.

Sam Weller once asked "Did anyone ever see a dead donkey?" and I would class with that inquiry, "Did anyone ever see a sheared rivet?" I have come across many cases of structural rupture—in one instance that of a vessel broken in two—and many instances of bottoms set up, plating torn and keelsons broken and distorted. Moreover, I have had to do with very many cases of damage by collision in which much material was torn asunder. But I have seen very few sheared rivets, and these for the most part have been in beam cases. From this it would seem that whatever deficiences there may be in the riveted joints of iron and steel vessels the faults are not in the rivets but in the materials riveted. A very old experience with butt joints in shell plating is the rapidity with which they waste at the bilges of comparatively long vessels, more especially when engaged in certain trying trades, as that of the North Atlantic. To obtain the speed desired in passenger service it is found desirable to maintain rather large proportions of length to depth. This, of course, tends, especially in steel vessels, to accentuate any tendency which may be set up in the way of bending in a seaway. Now, I do not suppose that in any well-designed and constructed steamer the bending can be very considerable, but it is easy to conceive that a movement, however slight, is often set up at the butts, and this movement will be greater on the outer than at the inner strakes of the plating, because the latter are afforded so much stiffening at their butts by the overlaps of the former. Moreover, the butt straps to outer strakes, when fitted on the inside of the vessel, do not extend to the full breadth of the butt. Now the corrosion which takes place at these butts is not simple oxidation. The butt joints when found wasted are always blackened, and the iron or steel is found converted into a carbonate of iron, very much resembling plumbago in appearance. I have never heard any authoritative explanation from a chemist in regard to this phenomenon, but there can be no doubt that the corrosion is due to the action of free carbonic acid gas in the sea water upon the iron or steel plating. That this action should be limited to these strakes seems to me to indicate that globulas of carbonic acid gas are imprisoned under great pressure between the butt joints of the plates every time the vessel is placed under a severe bending stress in a seaway. Be this as it may, the remedy of fitting outer butt straps is found to be a sufficient one.

The phenomenon of "panting" is one of interest and importance to naval architects. I suppose all of you have heard of "panting beams," "panting stringers," and so forth, but perhaps a personal inspection of what actual panting is in a ship may not have come under your observation. The term "panting" is suggestive of the phenomenon it serves to describe The tendency to "pant" in a vessel is most observable at the bow, but I have seen cases of panting at the stern also. The shape of a vessel's body throughout the greater portion of her length is such that a transverse section yields a curved frame which in itself is stiff, by reason of its form, against the water pressure on the outside. But towards the bow this curvature diminishes so that the transverse sections at that part are of a flatter form. This is especially the case in sharp vessels, and less so in the full-bowed cargo steamers now so commonly built. But in all vessels, whether sharp or full, the bow is the part that receives the first impact of the sea when the vessel is being driven through waves. As a consequence it has been found that there is a tendency for the comparatively flat sides of a vessel near the bow to yield under the influence of such extra sea pressure. The framing and plating is observed to move like the ribs of a man's body when the lungs are alternately inflated and emptied, or like a dog's ribs when panting. The result of this movement, when long maintained, is to start and loosen the riveting in the frames and shell plating, and in this way not only is the strength of the vessel diminished but her cargo is damaged also. To prevent this movement it is the practice to fit additional beams both before the fore peak bulkhead and for some distance abaft it, and in addition thereto to fit extra stringers and additionally attach them to the beams by means of gusset plates. In all cases the stringers should be wrought intercostally and attached to the shell plating. Even with these precautions, if not sufficient for the purpose, panting still goes on, and the connection between the panting beams and stringers gets torn away. Quite recently when surveying one of our earliest Atlantic Greyhounds I found that her panting beams were all broken clean away from the frames and stringers, and that they had fallen from their places in the fore peak. In this case the attachment between beams and stringers was insufficient to resist the panting stresses. All we had to do was to make the attachment equal in strength to the beams attached, and to ensure that these latter were sufficiently strong. All of which has now been done. I remember once surveying an iron sailing ship having a very fine after body, in which panting beams had been fitted. Upon examination all the panting beam knee rivets were loose, thus showing that not only do vessels "pant" at the after part, but that in this case the "panting" was more than the beam knee rivets could resist. Upon calling a shipbuilder's attention to this case in order to convince him that I was justified in asking him to fit similar panting beams in a vessel building by him, he replied that if the beams had never been put there I would never have known whether the vessel panted or not. This was intended to be smart, but in point of fact the tearing of beam knee connections is the least serious consequence of panting. All shipowners and, in fact, everybody who has to do with the North Atlantic trade, know only too well what a serious thing panting is, and how necessary it is to prevent it. It has been no unusual thing in days gone by for vessels to come under the riveters' hands after every winter Atlantic voyage to make good defects in the neighbourhood of the bow due to panting. It is safest in dealing with this malady to err on the side of too much rather than too little provision of what is commonly spoken of as "panting arrangements," when "arrangements to prevent panting" is meant. At all events, so careful are we now-a-days to brace up and stiffen the bows of steamers, that troubles through panting are becoming scarcer every year.

(To be continued.)

* A lecture delivered to the Glasgow University Engineering Society.

RAILWAY MATTERS.

THE Board of Trade have recently confirmed an order authorising the construction of a light railway from Summerhill-road, in the city and county of Bristol, to Hanham, in the parish of Kingswood, in the county of Gloucester.

WE are informed that Mr. Harry S. Wainwright has been appointed, from January 1st, 1899, locomotive, carriage, and wagon superintendent to the Managing Committee of the joint lines of the South-Eastern Railway and London, Chatham, and Dover Railway.

WE have received a copy of the Christmas number of the *Locomotive Magazine*, entitled "British Expresses, 1898." The number contains fifteen full page plates representing some of the best-known expresses on the leading lines of Great Britain and Ireland. The illustrations are reproduced from instantaneous photographs with really excellent results.

As a goods train was coming out of the down goods yards near Crewe Station, during Saturday night, to get on to the line for Manchester, it was run into by a light engine, which struck it obliquely, cutting it in two. An engine and several wagons were thrown off the line, and the goods traffic was blocked for several hours. No one was injured. The collision was stated to be due to a signalman's mistake.

ON Tuesday morning a railway accident occurred on the Glasgow and South-Western Railway, near Closeburn, ten miles north of Dumfries. A Glasgow goods express, when going at the rate of sixty miles an hour, broke away, and the second portion dashed into the first after crossing Cample Viaduct. Both up and down lines were blocked, and the English mail and Pullman passengers were delayed for four hours.

AT a general meeting of the London County Council held on the 29th ult., Mr. John Young, at present general manager of the Glasgow Corporation Tramways, was appointed Chief Officer of Tramways for the metropolis. The General Purposes Committee of the Council, to whom the selection of a gentleman for the position had been remitted, after personal interviews, unanimously recommended that Mr. Young be appointed. There were seventy applicants for the post.

THE Science and Art Department has lately placed in position at the South Kensington Museum a large diagram prepared from official drawings, showing seven of the Great Western Company's early locomotives, namely:—North Star, Vulcan, Lion, Ajax, Fire Fly, Iron Duke, Lalla Rookh. They are all drawn to lin. scale. The Iron Duke has its tender; all the others are without tenders. A list of details and dimensions, and the section of the railway, are also given.

A COLLISION occurred on the Midland Railway on Wednesday at Ynysgeinon, Brecknockshire, resulting in injury to six passengers. Four carriages had been detached from a Swansea train for conveyance to Brynamman, Carmarthenshire. An engine which was sent to take them on got out of control, and dashed with considerable force into the coaches. The guard, who was standing at the end of the rear carriage ready to couple the engine, had a narrow escape, leaping aside just at the moment of the contact. Little damage was done to the rolling stock, but the passengers were badly shaken, and six received contusions and flesh wounds.

APPLICATIONS for light railways are received by the Light Railway Commissioners twice a year, in the months of May and November. The applications received in November, 1898, amounted to fifty-four, under which it is proposed to construct 192¼ miles of line at an estimated cost of £3,344,563. This estimate is for construction only, and does not include the cost of plant and rolling stock for their equipment. This is the largest number of applications that has yet been received by the Commissioners in any one half-year. The total number of applications previously received in the four half-years since the appointment of the Light Railway Commission in 1896, amounted to 121 for 1302¼ miles of line, at an estimated cost of £7,555,976 for construction.

IT is publicly notified that in the ensuing session of Parliament power will be sought to incorporate a company to construct a ferry, to be worked by electricity or other power on submerged rails, across the river Thames, with roadways and approaches thereto for the passage of vehicles, foot passengers, animals, and general traffic, as also with generating station and electrical or other machinery and appliances. The ferry as proposed will run from a point at or near the site of Brewhouse-lane, one chain or thereabouts to the west of the Ship Hotel, terminating in the parish of All Saints, Poplar, at or near the western boundary of the Island Gardens. It is proposed to take power to sell or lease the undertaking or any part of it to the Corporation or the London County Council or any corporate body, or to make agreements with such authorities with respect to the construction, management, and maintenance of the undertaking.

THE Tramways Committee of Dundee Town Council have decided to introduce the overhead system of haulage in connection with the tramway system of the city. Professor Kennedy, London, who had been asked to act as consulting engineer, wrote briefly advising the overhead system to be adopted, and maintaining that the conduit principle was as yet only at the experimental stage. Discussing the advisability of delay in deciding to adopt the overhead system, in view of the possibilities of the conduit system, a member of the Council contended that even supposing the conduit system were a success, and the initial expense with it were not less than between £5000 and £6000 a mile more than the overhead system, no one, surely, would be prepared to recommend its adoption. After a few years, if the conduit system were proved a success, nothing would be lost by meantime adopting the overhead system, and subsequently introducing the conduit in the centre of the city. This would simply mean the removal of the posts and wires to some suburban portion of the lines, and the saving in the first year by the adoption of the overhead system would be enough to enable them to meet any losses they had made by having first erected the overhead system and then having to take it down. The proposal to adopt the overhead system was carried by twenty-three votes against four in favour of remitting the matter back for further consideration.

NOTICE has been given of an important railway scheme which will extend to a distance of between fifty and sixty miles, mainly in the county of Lanark, but traversing the northern part of Dumfries-shire. The line, which is called the Glasgow, Motherwell, and Sanquhar Railway, branches off from the City Union Line of the Glasgow and South-Western Railway near Eglinton-street, running south past the east side of Eglinton Toll, goes thence in a south-easterly direction through Govanhill, Rutherglen, Cambuslang, passes near Blantyre, and onward through Stonehouse, Lesmahagow, Douglas, and Crawfordjohn. Several miles beyond Crawfordjohn the line enters Dumfries-shire, and passing Kirkconnel, joins the Glasgow and South-Western Railway about 1000 yards to the south of the present railway station at Sanquhar. Power is sought in the Bill for the construction of branches to the Paisley and Canal Line, and to Hamilton, Motherwell, and Wishaw. It is evident that the object of the line is to bring the Glasgow and South-Western Railway into the coal and iron fields of Lanarkshire. This would give them a valuable traffic to and from their harbours at Irvine, Ardrossan, and other ports on the west coast. The new line will also have the further advantage of affording improved facilities for passenger traffic, and shorten the road from Glasgow to Sanquhar. The Glasgow and South-Western Railway Company are supposed to be the promoters of the scheme.

NOTES AND MEMORANDA.

DURING last month Scotch shipbuilders launched nineteen vessels of 31,213 tons. The aggregate for the eleven months of this year is 409,948 tons, an amount greater than that of any other whole year.

AS the result of experience acquired in the late war with Spain, the United States naval authorities have decided in future to paint their battleships a dead grey colour with a yellowish shade. This mixture is said to approximate most nearly to the colour of rock and of the obscured horizon.

ACCORDING to the returns of the Association of German Iron and Steel Manufacturers, the total German output of pig iron in October was 651,122 tons, which compares with 614,497 tons in September, and with 611,779 tons in October, 1897. The previous largest monthly total was 626,871 tons in January last.

A NEW process is announced for seasoning wood by electrical action. The timber to be treated is put into a quadrangular tank of liquid, immersed to rather more than half its depth, and an electric current applied through a metallic conductor, so arranged as to distribute it throughout the area, and it is stated that in a space of four minutes the sap begins to exude at the lower end of the wood; in six hours it is all extracted. The wood is then placed in another tank from which a septic solution is forced into the pores by an electro-capillary method. If, says the *Builder*, this process has successful results at a cost which will not be commercially prohibitory, it may prove of great importance.

LATEST official statistics of the German Empire show that there is used by the German industries, including commerce and traffic, horticulture and stockbreeding, a total of 3,421,194-horse power. The various sources of power are given in the table following:—

Source.	Horse-power.
Wind	18,864
Water	629,065
Steam	2,715,078
Gas	53,841
Petroleum	7,249
Benzine, gasoline, &c.	3,501
Hot air	1,298
Compressed air	11,162

Electricity was employed in 2245 establishments. In the mining and iron industry there were employed 994,050-horse power, or almost one-third of the total. In the manufacture of foodstuffs 686,279-horse power were used, in the textile industry 514,986, in the machine industry 182,767, and in the chemical industry 83,164.

THERE has been some talk lately about the existence of a lake in the sandstone at Reigate. From the description the *Builder* presumes the upper greensand formation contains it. Some workmen first of all discovered a series of caves, which consist of several chambers about 24ft. by 20ft., and each chamber has a door communicating with the next. On the floor of the first cave broken into washed sand lay to the depth of 4in., showing that running water had been at work, and further search proved the existence of a spring of water. Not content with this wonderful discovery, the floor of the cave was broken up, and the explorers were rewarded by finding a "real lake of pure soft water." No mention is made as to whether fairy boats or the usual accompaniments of such underground finds were seen. Our contemporary presumes that the "dailies" will now give us "underground lakes" day by day; there is plenty of similar material to work upon, and it would be useful from the point of view of water supply. This particular lake is said to be capable of yielding 500,000 gallons of soft water per day. The "caves" alluded to are doubtless old stone mines.

BEFORE a meeting of the members of the Royal Scottish Society of Arts, held recently at Edinburgh, Mr. Gilbert Thomson, C.E., read a paper on "Drain Testing," in which he advocated a standard system. Since the desirability of having an air-tight system of house drainage was first recognised, many improvements had, he said, been made both in construction and in methods of testing. At present the standard of construction appeared to be rather above the standard of ordinary testing. For new work it was desirable to have a positive, and not only a negative proof of soundness. Two such tests were available, and frequently used—the water test and the air test. The latter was the more generally applicable, and might be made a standard to which all drains and pipes put in under building bye-laws might be made to conform. So far it had usually been applied in a rough-and-ready fashion, and even then was much superior to smoke. It could easily be made to give exact numerical results, and the suggestion was that bye-laws and specifications should not stipulate in general terms that the work was to be satisfactory, but that it should stand an air pressure of so many inches of water, and should retain it without perceptible loss for so many minutes.

AT a recent meeting of the Society of Naval Architects and Marine Engineers, held in New York, a paper was read on "Portable Pneumatic Riveters in Shipbuilding," by Mr. W. I. Babcock. The author stated that with portable pneumatic riveters and in-deck and tank-top work three men and a heater boy would drive from 800 to 1000 rivets in a day. As to the quality of the work done, it was stated that the rivets are first-class in every respect, while the saving over hand riveting was from one to two cents. per rivet, or 4000 dols. to 5000 dols. in a 4000-ton steamer. Another important advantage was that the high-handed riveter could be replaced by unskilled labour. In the discussion which followed one speaker stated that at the yard of Messrs. Harland and Wolff an immense gantry spanned the whole ship under construction and carried the riveter on special cranes, which themselves travel up and down and bring to bear a pressure of from 40 to 50 tons on the rivet, the plant being specially designed for work on the Oceanic. The firm had ordered a duplicate plant for smaller work. In replying, Mr. Babcock said that the reason he favoured pneumatic over hydraulic riveters was that the former could be manipulated by hand, and there was no reason why 2in. rivets could not be driven satisfactorily. The gantry crane was, he added, an extremely expensive construction.

AT a meeting of the Institution of Engineers and Shipbuilders in Scotland recently held, Mr. A. E. Shute read a paper on "Feed-water Filters." The author referred to the danger of permitting foreign substances to enter boilers, and said that by the great improvements in evaporators, which were really filters or separators dealing with matters in solution, no sulphate or carbonate of lime or salt need ever be found in a boiler. Some filter deposit was found to contain 60·7 per cent. of organic matter and moisture and 39·3 per cent. of mineral matter. Of the former, 37·8 per cent. consisted of fatty acids, and 15·3 per cent. mineral oil. Oil, when deposited on the heating surfaces of a boiler, was one of the chief causes of loss of efficiency, collapse of furnaces, and straining and buckling of fire-box plates. Oil being lighter than water, one would naturally think, he remarked, that it would remain on the surface, but, as shown by Professor Lewes, it did get below the surface. Oil, if used at all—either directly in the engines or indirectly in swabbing piston and valve-rods—should, he said, be purely mineral oil, and not mineral oil adulterated with vegetable or animal oil or fats, as the latter, besides furnishing the fatty acids, were dangerous from the property they possessed of being converted into a state whereby they could enter into solution with the feed-water, and thus pass any filter made. Mineral oil did not possess this property in anything like so marked a degree, and could, therefore, be trapped on its way to the boiler.

MISCELLANEA.

WE understand that the first meeting in the New Year of the Institution of Mechanical Engineers will be held in their new home at Storey's Gate.

IT is said that the bicycle season of 1899 will see the introduction into this country of a "fifteen dollar" machine by one of the largest manufacturers in the United States. What next?

THE steamer Londonian, of the Wilsons and Furness-Leyland Companies, has been found abandoned and in a sinking condition in the Atlantic. She carried no passengers, but her crew of eighty are missing.

ON Saturday last a fire broke out in the Royal Arsenal at Ferrol, and effected damage, it is estimated, to the extent of 4,000,000 pesetas. The naval stores and fittings ready for the Cardinal Cisneros battleship were burned.

THE Admiralty have ordered Messrs. Laird Brothers, Birkenhead, to build two twin-screw sloops, to be named the Mutine and Rinaldo. They are to be similar to, but rather larger than, the Rosario and Condor, building at Sheerness.

THE United States Consul at Bogota has informed Mr. Hay, Secretary of State, that the Colombian House of Representatives has rejected the petition of the Panama Canal Company to extend for six years the time for completing the canal. The company has still six years to carry on work.

THE Margate surf boat, Friend of all Nations, was lost on Wednesday night, the 30th ult., whilst attempting to reach a steamer in distress. It is a singular coincidence that the occurrence happened on the anniversary of the capsizing of the boat last year. All the hands were saved by the tug Harold, which was on her way from the Thames to the Dover harbour works.

THE Clan line steamer Drummond foundered on Thursday, the 1st inst., in the Bay of Biscay. She left Liverpool on the 23th ult. for Algoa Bay, Port Natal, and Delagoa Bay, with sixty-two persons on board, thirty-five of whom were drowned. The Clan Drummond was a screw steamer of 2908 tons gross, built at Glasgow in 1882, and belonged to Messrs. Cayzer, Irvine, and Co. According to the survivors a huge sea carried away the bridge, and the vessel sank almost immediately.

MANUFACTURERS contemplating sending travellers to Denmark should bear in mind that commercial travellers in that country are placed under certain restrictions. Every traveller must have a licence, for which he is taxed about £9. The licence is available for a year, and has to be inspected by customs and police authorities in all the towns he calls at. If he omits to show his licence he is liable to a fine not exceeding £5, and if he commits the offence a second time he is liable to have his licence cancelled and be politely requested to get out of the country. He must also have a certificate, drawn up in legal form, properly accrediting him to his firm, while if he represents more than one firm he will have to pay one half of the amount of the tax for every firm he represents.

THE new naval dry dock soon to be built by the Government at Boston, U.S.A., will have the following dimensions, according to a published interview with officials of the Navy Department:—Length, 750ft.; width on floor, 80ft.; width at top, 114ft.; width at entrance, 95ft.; depth to floor, 40ft.; depth on sill, 30ft. It will be built of granite, or concrete faced with granite. The steel caisson gate will be about 95ft. long, 36ft. deep, and 24ft. beam. The pumping plant will include three 45in. centrifugal pumps. If built entirely of granite, about 576,000 cubic feet of cut stone and 1,390,000 cubic feet of rubble masonry will be required; if concrete faced with granite, the quantities would be about 256,000 cubic feet cut granite and 1,710,000 cubic feet of concrete.

IT is rather singular, says *Fairplay*, that whilst the name and praises of James Watt are annually remembered on Clydeside on the recurrence of his birthday, there is not a British steamer afloat larger than a lighter bearing the great engineer's name. Formerly there was a James Watt tramp steamer belonging to Greenock, but she was sold to foreigners and had her name changed some years ago. The same owners followed up the James Watt with the Newcomen, which has also been sold to foreigners, and now figures under another name. So that there is a clear field for the owners of some of the numerous boats now building on the Clyde to do honour to the memory of notable engineers of the past by bestowing their names on their vessels, which would be much more appropriate than the extraordinary names adopted by some Clyde owners for their boats.

THE arrangements for the development of liquid fuel appear to be making progess at the Admiralty as well as in mercantile circles. The experiments on the torpedo boat destroyer Surly are encouraging, and are leading to further developments, says *Fairplay*. Different kinds of oil are to be tried so as to ensure that favourable results are not dependent on one kind of fuel only. There is no structural difference between the general arrangements of a torpedo boat destroyer for burning coal as compared with burning liquid fuel; but, so far as detailed modifications are concerned to enable liquid fuel to be burnt, the change can be effected inexpensively and without laying up a vessel for any great length of time. In the new destroyers which are about to be built, the possibility of the future addition of liquid fuel arrangements will, according to our contemporary, be kept in view, and in the meantime the experiments and arrangements for the continuous supply of liquid fuel are to be pushed on.

THE packing of the American cotton bale is again causing trouble abroad, regardless of the repeated warning of American consuls on this head, says an American contemporary. Reports from Liverpool say that English companies are refusing to insure against loss from "wet and mud damage" due to loose and badly-packed bales of American cotton. It is estimated that the claims arising from cotton thus damaged and delivered at Liverpool during the last season will aggregate 500,000 dols. The English insurance companies sent an agent to the United States to investigate the cause, and the blame is placed partly upon the producer and partly upon the transportation companies. A closer and better woven covering is urged; but the chief requisite seems to be greater care in both packing and transport, and some decrease in the belief that foreign nations must take our cotton "any how." Indian and Egyptian cottons are active competitors, and the splendid condition in which cotton from these countries arrives in England is a very sharp contrast with our own.

THE productive resources of all the main shipbuilding centres being now taxed to the uttermost, shipyards and engine works both on the Clyde and the North-east coast are not only being extended, but others, inoperative and partly dismantled for some time, are being re-started as overflow establishments by firms whose orders compel such a step, or by new firms whose prospects justify it. At Port Glasgow, Messrs. Hamilton and Co. are re-starting the Newark yard, which has for years been inoperative; at Yoker, the shipyard formerly occupied by Messrs. Napier, Shanks, and Bell, is being again set agoing by a new firm, Messrs. Napier and Miller, Limited; the shipyard at Ardrossan formerly carried on by the Ardrossan Shipbuilding Company is about to be re-started by a new proprietary, the representatives of which hail from Glasgow, Sunderland, and Newport. At Londonderry the Foyle Shipbuilding and Engineering Works, which under various managements have produced important shipping in the past, are again about to be set agoing under the management of two experienced and practical gentlemen from the Clyde and the Newcastle districts. Much of the plant is being renewed with the latest and most improved machinery, and the works will shortly be in operation on all classes of work.

THE IRON AND STEEL INSTITUTE.

No. VIII.

OUR pleasant reflections on the old-world charms of Laxå were soon interrupted by our arrival at Degerfors, which is on the line connecting Stockholm and Christiania, and in proximity to the railway there stretched in

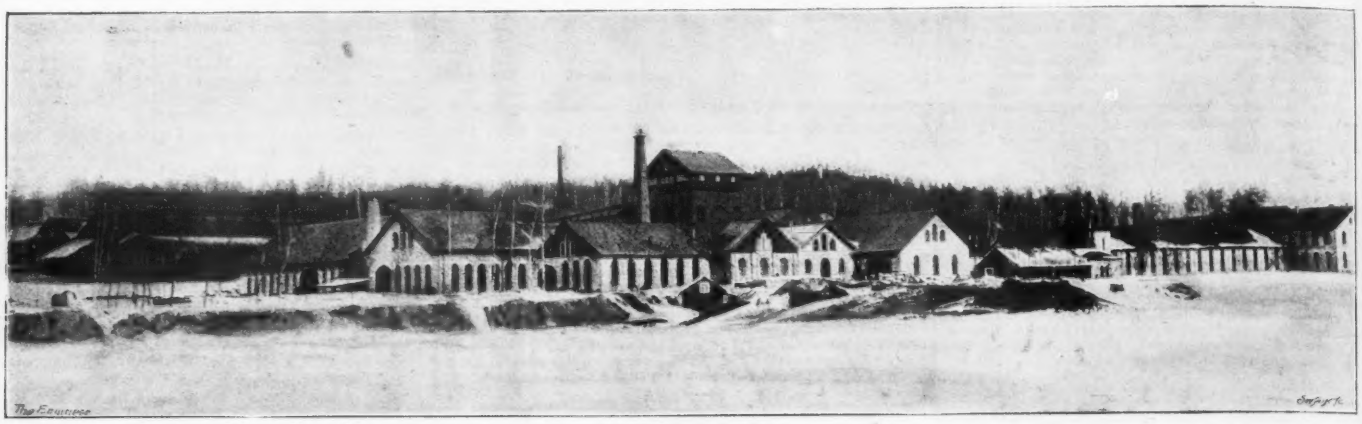


Fig 1—BOFORS STEEL FOUNDRY

begrimed grandeur an extensive perspective of irregular buildings, which proved to be the Degerfors Steel Works. They displayed evident signs of the use to which they are put; and, moreover, of having been the scene of considerable activity. Further evidence that that activity was still extant was furnished by the large amount of building material that was lying about, which, by the way, was quite an interesting exhibition of granitic and gneissic rock specimens that delighted the petrologists of the party. The external appearance of these works was indeed striking; but the interior was still more so, for the first structure to be entered was a vast, lofty, spacious building which seemed to contain innumerable mills, with their accompanying re-heating furnaces and squads of ever-moving, perspiring, half-clad men. In all directions there was action, the cumbersome mill gear and rolls rumbling on incessantly to the right and left; the flitting about of metal in all stages of hotness, from dull red to white, and in all forms, from ingots to plates, sheets, bars and rods; and on the extreme right, towering somewhat above the rest in ponderous rectangular solidity, a bench of open-hearth furnaces in full work; yet all with a remarkable absence of any appearance of steam. A further examination disclosed no less than nine mills under this single roof, with all their accessories, and in addition the row of three ten-ton open-hearth furnaces, with one long casting pit in front. These, too, were tapped simultaneously at the time of the visit, and produced an effect that it would be difficult to exceed in brilliancy as a pyrotechnic display. The ingot moulds were arranged in a double row in the casting pit, and the metal was run from each of the three ladles into two moulds at a time. The moulds in use were of two patterns, some round with trunnions and others square and made in two pieces.

There are many notable features about these works, amongst others the mills are driven direct by turbines, each mill having its own; then many of the re-heating furnaces are provided with plates cooled with water in the front, which facilitated their working in a marked degree; further, there were some excellent machine cutting tools for shaping sheets, and here, too, the rolling of tubes could be witnessed—the hollow billet for the purpose is punched from the ingot under the steam hammer by driving it over a mandril and through a die. The material produced here is of excellent quality, and an example of this as regards plates was on view; it consisted of a ship's plate that had been crumpled up in a collision, and although it resembled a piece of a huge concertina in appearance, there was no sign of a crack visible. To ensure getting the material of the desired quality, the pig iron is produced at the works; for which purpose there are two blast furnaces 55ft. high, 6ft. diameter at the throat, 10ft. at the boshes, and 4½ft. in the crucible. One of these was tapped in the presence of the visitors. The pigs are cast in moulds, into which the stream of molten metal is directed by a movable runner. The blast is delivered at a temperature of 350 to 400 deg. Cent., and at a pressure of 1½ lb. The engine-house contains blowing engines of the inverted vertical type, with balance cylinders, and a 150-horse power dynamo, both driven direct by turbines. The dynamo is to supply current at 250 volts for new workshops. Outside the works there were two factors of prominence, the one the rapid voluminous river—Let-älfven—that contains an abundance of motive power, much of which at present runs to waste. This is to be modified, for in the near future the water will be held back by a dam that is in course of construction, which, too, had made considerable progress towards completion at the time of this visit, and when completed will render

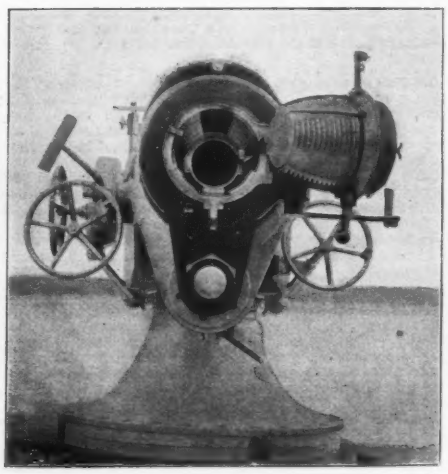


Fig. 2—BREECH MECHANISM OF BOFORS GUN

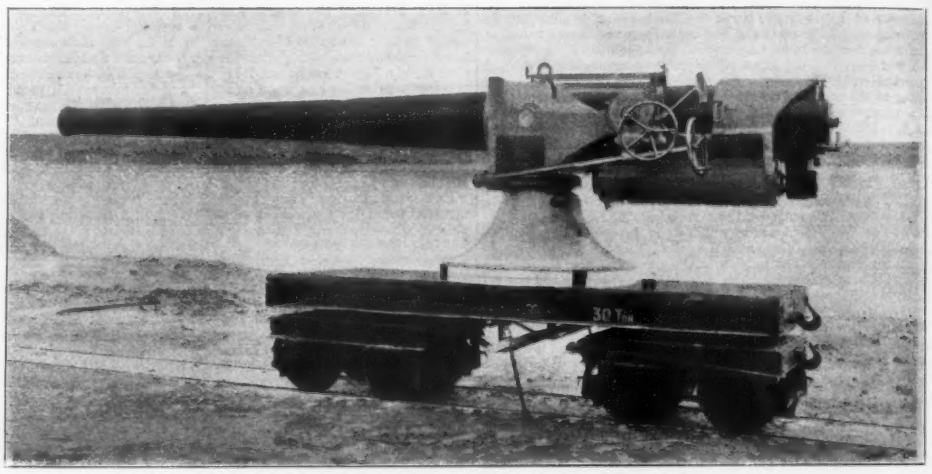


Fig. 3—BOFORS 15 c.m QUICK-FIRE GUN

Fig. 4—CAST STEEL ARMOUR PLATE

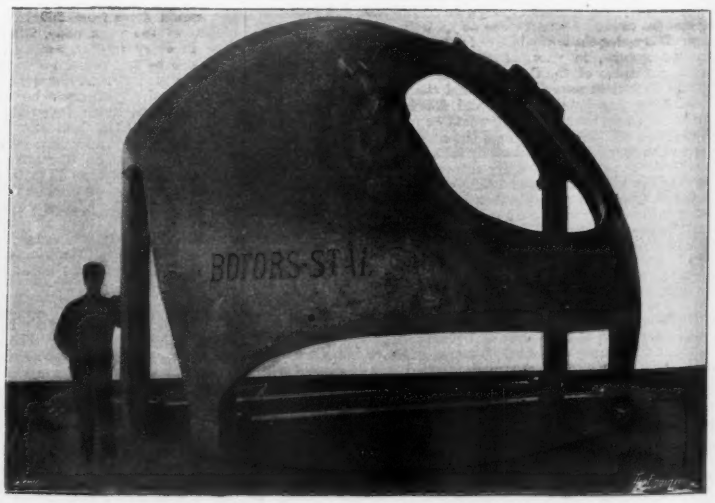


Fig. 5—SHIELD FOR 12in. GUN

a minimum of 4000-horse power available. The other prominent feature outside was the great piles of limestone and ores from different districts, Nora and Persburg amongst others; the ores are calcined—there are two calcining furnaces for the purpose—and are blended in the blast furnace charge to ensure the desired quality of the product.

It remains to say that these works were originally chartered by a Royal Decree dated June 15th, 1654, and now belong to the Strömsnäs Jernverks Aktiebolag, which was established in 1886, the output being at the present time more than 20,000 tons of open-hearth steel per annum.

The inspection was followed by luncheon, provided by the company, and served in a bowling alley, which had been adroitly transformed into a prettily decorated dining place, the magnates of the party occupying, at a special table, the position of the temporarily dispossessed ninepins. The position was excellently selected, being charmingly situated in a garden overlooking the rapid and picturesque river that rushed along below. This enjoyable item of the day's programme came to a close with hearty votes of thanks to the hosts and to the guides. The train being gained, it sped off on its way to Bofors, eleven miles distant, amidst cheers from many gathered amongst the trees to see the party off. A nice card of views of Degerfus Steel Works was distributed, but unfortunately they were too darkly printed to serve for reproduction.

Bofors is on the Nora - Karlskoga line, and a broad road from the railway leads to a well-kept verdant open space, on two sides of which are the residences of the managing director, Captain Dyrssen, and some other officials, whilst the side away from the line opens on to a garden that slopes away downwards, and a fine view is obtained of a broad fertile valley, and of the well-wooded hills beyond. In this pleasant place, beneath the Swedish flag flying from the flagstaff in the centre, the introductions were made, and the party was divided into groups to inspect the Bofors Iron and Steel Works and the Bofors ordnance factory of Aktiebolaget Bofors-Gullspång.

Bofors has been the scene of an iron industry since 1646 at least; but it was of no great importance until 1870, when the works were greatly enlarged, whilst the present company was established in 1873, and the illustration Fig. 1 presents a view of the Bofors steel foundry and workshops belonging to the company, and will give some idea of the magnitude of the operations of this corporation, when it is borne in mind that this is only part of the works at Bofors, and that there are works at Björneborg, Gullspång, and elsewhere in the same ownership, which, however, were not visited by the excursionists. We may, however, remark here that the Björneborg Steel Works are equipped with two blast furnaces, two Bessemer converters, and a large steam forge, and that the average production of the company's iron and steel works is about 15,000 tons a year.

The Bofors Iron and Steel Works is provided at present with one blast furnace and a calcining kiln, two open hearth furnaces, thirteen furnaces for making charcoal blooms, five rolling mills for bars, rods, hoops, and sheets, and a steel foundry. As a matter of fact, the treatment as regards iron and iron ores is similar to that already mentioned in connection with the Laxå works.

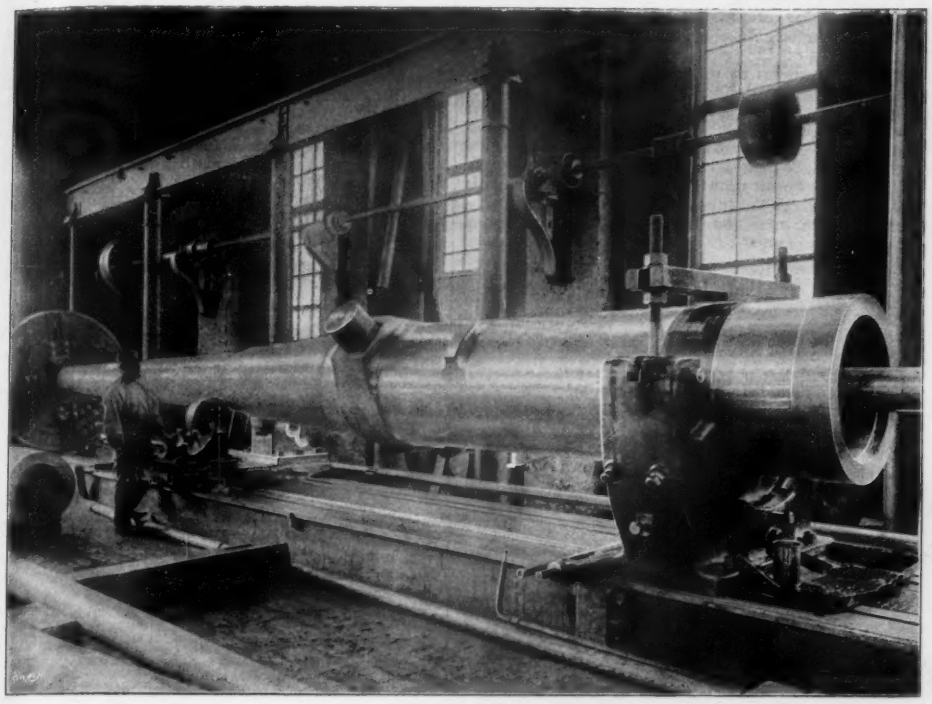


Fig. 6—25-CENTIMETRE GUN

Ores from Striberg, Haggrufvan, and Persberg mines are calcined and used in appropriate admixture in the blast furnace, which is 50ft. high, 9ft. at the boshes, and 4ft. in the crucible, and from which 100 to 120 tons of pig is drawn a week, the pigs in this instance being cast in sand, and at the present time are being made with 0·15 to 0·18 per cent. of silicon, the consumption of charcoal being from 17 cwt. to 19 cwt. per ton of pig. The pigs are converted into malleable iron in Lancashire hearths, two of which are double, and are worked from both sides without mechanical aid, whilst the others are fitted with the mechanical rabbler already noticed at Laxå. In the latter hearths the charge of pig is about 3 cwt., and in the former about 3¼ cwt. All these hearths are supplied with blast at 230 deg. Cent. through water-cooled tuyeres, and the pigs are pre-heated as in other works already noticed; the lumps, too, are shingled under the tilt hammer, and rolled down into bars, wire, &c. But there are a few points of difference to be observed. Firstly, in the bloomery the charcoal is stored in hoppers placed between each pair of hearths, and fed from above by an overhead tramway; secondly, in the mill the re-heating furnaces are not gas-heated, most being wood-fired, whilst in others coal is the fuel, and is fed in by an automatic feeder, in which the coal is charged by hopper and bell into a holder, covered above and closed below by a disc that can be adjusted at any desired distance from the bottom of the holder, to suit the size of the coal. The disc is attached to a shaft that passes through the holder, and by means of a ratchet and pawl is given a rotary motion, which is transmitted to the disc, with the result that the coal is delivered continuously and regularly in just the quantity that is desired, and the required temperature is constantly maintained. These furnaces are flat near the grate, and slant upwards towards the flue, and, as in the other furnaces, the cold billets are charged at the cooler end of the furnace and push those already in further forwards or on to the flat portion, from which they are withdrawn as required. The whole arrangement appeared to work very well, but one would have liked to have a little more time to examine it. There was here, too, a special charging appliance, the billets in couples being lifted by a small hydraulic hoist to the level of the charging doors, and then pushed into the furnace by a ram worked by a rack and pinion; which, however, was not seen in operation. Further along in the mill the disposal of the wire rod after passing the last roll was better managed than in the other works, for it was coiled on a reel, from which it was readily removed and stacked on one side much more expeditiously than the length of straight rod. It may be mentioned that this mill is used almost exclusively for iron, the steel being used mostly for castings, so that only any excess of that material finds its way to the mill.

The manufacture of the steel is one of the most important operations at Bofors, for they specialise in guns and other objects made from unforged steel cast without blow-holes. The utmost precautions are taken to ensure the purity of the materials, and the steel-making is conducted in open-hearth furnaces fired with producer gas made from wood, and the practice usual in the production of steel that will cast without blow-holes is followed, namely, ferro-silicon or ferro-manganese is introduced just before drawing the bath, or when nickel steel is being made the nickel is put in the furnace and some aluminium is put in the ladle. The drawing of a 12-ton charge was witnessed on the occasion of our visit. In front of the furnace a Y-shaped runner was mounted, with a ladle each side, and the stream was directed first to the right into one ladle and then to the left into the other. The ladles were then lifted by cranes and readily adjusted over the work, which in this case was a 12-ton ring for the breech of a big gun; a similar ring was later on seen in the yard, whilst another of them was being turned on a lathe in one of the shops. In both instances they were closely examined, and certainly presented examples of high quality castings. However, there was plenty of other examples illustrative not alone of the goodness of the work, but also of its diversity, and the illustrations we give set forth more examples. Fig. 2 is a side view of a quick-firing gun, having the following data:—Calibre, 15 centimetres; length in calibres 45, in centimetres 675; number of grooves, 44; depth of grooves, 1 millimetre; width of grooves, 7·2 millimetres; width of lands, 3·5 millimetres; twist at breech, 60 calibres; twist at muzzle, 30 calibres; weight of gun, 5560 kilos.; weight of carriage, 3200 kilos.; capacity of bore and chamber, 118·2 litres; capacity of cartridge case, 12·53 litres; weight of projectile, 40 kilos.; weight of charge, 8·19 kilos.; capacity of cartridge case per kilo. of powder, 1·53 litres; muzzle velocity, 801 metres; muzzle energy, total 1310 metre-tons; per kilo. of powder, 160 metre-tons; per kilo. of gun, 236 metre-kilos.; range, with elevation of 17 deg., 10,300 metres; velocity of projectile at 1000 metres, 685 metres—at 2000 metres, 581 metres; perforation of wrought iron at muzzle, 48 centimetres; at 1000 metres, 39 centimetres—at 2000

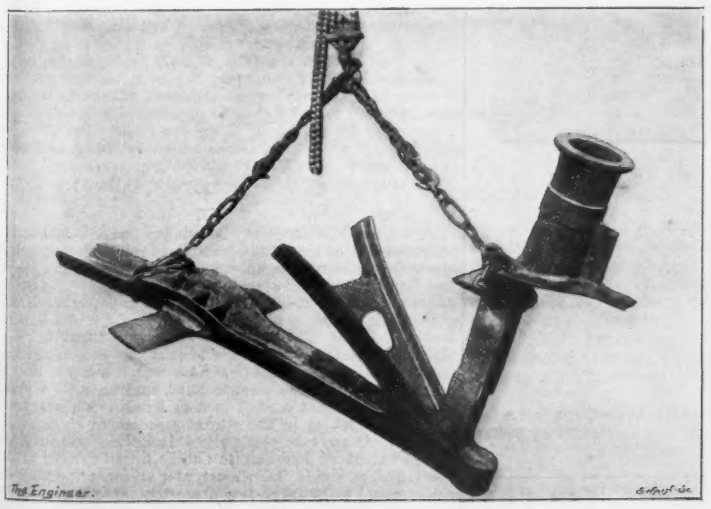


Fig. 7—STEEL STERN POST

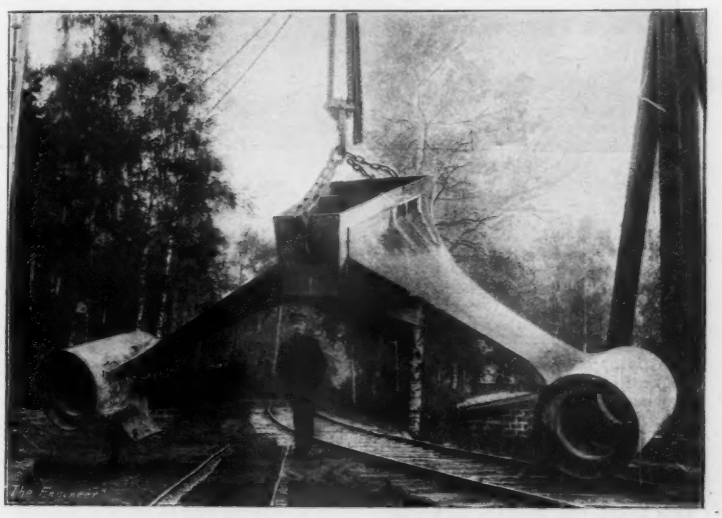


Fig. 8—STEEL TAIL SHAFT BRACKET

metres, 31 centimetres; length of recoil, 30 centimetres. We have retained the metric quantities for the sake of exactitude, and because the guns are manufactured, gauged, and registered in accordance with metric standards. Fig. 2 shows the rear end view of the same gun, and exhibits the mechanism adopted by the Bofors Company, and which we shall probably refer to again later on. Suffice to say now that the mechanism consists of closing gear, consisting of an ogival screw, a cover, locking lever, and accessories of firing and extracting mechanism.

The closing gear case is shown in the illustration, the advantages of the ogival screw over the cylindrical screw is that the former can be swung aside immediately after revolving it $\frac{1}{8}$th of a turn on its axis, whereas the latter requires many turns before it can be swung aside. The firing and extracting mechanisms, except the projecting levers, are within the cover.

Whilst we are on the subject of guns, it may be noted that what is claimed to be the longest ingot in the world was cast in the gun casting pit at Bofors, it was 16 metres in length and 16 tons in weight. The top 6 metres was cut off as a dead head and the remaining 10 metres bored for a 25-centimetre gun, which was seen later on in the gun shop, and is shown in Fig. 6.

Fig. 5 represents a shield for a 12in. gun, of which the upper part is a single casting and is screw-bolted to the lower portion; it weighs 15 tons and its magnitude may be gathered by comparison with the man alongside. Fig. 4 shows a bent cast steel armour plate made for the ironclad Odin. It was originally $7\frac{1}{2}$ tons, and finished $6\frac{1}{2}$ tons in weight, and 91 millimetres, or 3·583in. thick. The other dimensions may again be gathered from the figure standing by. Armour plates up to 20 tons in weight are cast at these works, and we witnessed the heating watched. The electric crane running on the gantry serves for manipulating the gun tube. A tube for a 15 cm. gun was in the furnace at a low red heat at the time of our visit, and during the afternoon the various groups of excursionists were assembled together to witness the withdrawal from the furnace and the plunging into the oil; the former went very smoothly when once the doors of the furnace had been opened. The gun tube showed no redness in the daylight, but nevertheless when plunged into the oil created a great disturbance, accompanied by a strong rush of flame and smoke, first from the mouth of the descending tube and then from the whole surface of the well, sending a high roaring column of flame and smoke far above the top of the structure. Earlier in the proceedings some members of the party grumbled at being urged by our kindly guides to withdraw from the immediate vicinity of the well during the progress of the operations, but were subsequently quite satisfied to have witnessed the remarkable display from the distance as recommended. The spectacle reminded us of a natural oil well on fire.

It may here be mentioned that this is not the only treatment to which the tube is submitted to get it into the proper molecular condition to suit the purposes of a gun. Starting from the ingot the head is removed and the cast block is thoroughly reheated, and embedded and allowed to cool completely, in pulverised cinders. Then after being rough finished and bored to a diameter slightly less than the regulation calibre, it goes through the treatment just previously described, after which it is annealed at a very low temperature, and is then ready for finishing.

The visit included an inspection of the shops —one of them is illustrated in Fig. 9—and great

Fig. 9—GUN SHOP

laborious task of cutting a shoulder in a plate and the impressive sight of the bending of a plate cold in a 1000-ton hydraulic press which, by-the-bye, was one of the very few machines of English make observed at the works, and came from Messrs. Greenwood and Batley, of Leeds, who had also a gun-boring machine in another part of the works.

Intricacy or delicacy of design does not thwart our Bofors friends any more than magnitude of weight, as may be seen from Figs. 6 and 7, the former representing the sternpost, weighing nearly four tons, for the Danish ironclad Herluf Trolle; the latter the stern brackets for the shafts of the twin-screw propellers of the Czar of Russia's pleasure yacht Standart. Its weight was $9\frac{1}{10}$ tons, and its size and peculiar character for casting may be gathered from the illustration.

In fact, ordnance and other material is made in considerable quantities every year at Bofors; not alone for Sweden but for other States, and includes guns up to 10in. bore, gun carriages, armour plates for ships and for fortress work, armour-piercing projectiles, &c., and many specimens of them could be seen about the works or in stores. But the most inspiring spectacle of the Bofors visit was connected with the most conspicuous piece of apparatus in the place, that being the plant for re-heating and oil-tempering gun tubes, a construction that, it was stated, cost 80,000 krone. It comprises an oil well about 50ft. deep and a superstructure some 70ft. high, consisting of four substantial but graceful brick columns, supported on a heavy gantry, with a housed-in travelling electric crane on the top. At one side there is a vertical re-heating furnace, which, in the front towards the oil well, is provided with a series of doors for the admission and removal of the gun tube under treatment, whilst a series of gas nozzles run up the back of the furnace for firing, and a looking-glass placed at an angle of 45 deg. in a covered pit below ground, enables the interior of the furnace to be inspected and the progress of the pieces of work were seen in various degrees of finish; also a peep at the gun and other stores of finished articles, as well as a view of the laboratory. Space will scarcely permit any full reference to these, but we may note that all departments are good and well equipped, and that the machinery is mainly of Swedish or German manufacture; for beyond the gun-boring machine of Messrs. Greenwood and Batley, already referred to, no further piece of English manufacture was conspicuous.

Some tests were witnessed in the laboratory, and a few results that have been obtained with Bofors cast steel may be quoted here:—

Year of casting.	Open-hearth cast steel for the following purposes.	Test piece. Diameter, mm.	Test piece. Area, sq. mm.	Limit of elasticity.	Maximum resistance, kilos. per sq. mm.	Elongation per cent. in place 100 mm.	Contraction.
91	Tube for 8 cm. field gun	18·10	257·20	36·54	68·04	18·4	27·6
91	Mantle for ditto	17·95	253·06	35·17	62·56	15·7	22·5
92	Carriage for 15cm. gun	18·60	254·47	27·90	57·77	15·6	12·9
91	Rudder frame	20·05	315·74	23·44	50·80	25·2	24·7
91	Stern-post	20·05	315·74	21·53	52·29	23·6	32·3

The company has a fine collection of photographs, some albums of which were distributed, and from these our illustrations have been prepared. The visit terminated most agreeably by a pleasant banquet, which was brightened by the presence of ladies, and was served in Captain Dyrssen's private residence on behalf of the company. At eight o'clock the party broke up, with expressions of thanks and feelings of regret; the train was regained and a start made for Filipstad, some sixty miles distant, which was reached before midnight.

DOCKYARD NOTES.

WHAT is likely to be the effect of 6in. or smaller shell bursting against casemates or turrets in close proximity to the gun—a little above the piece or a little upon one side? There are, we believe, two diametrically opposite theories—one that a shell bursting within 6ft. or 7ft. of the gun will destroy the projecting muzzle, the other that no harm will ensue. We cannot recall any experiments with the direct object of solving the problem. Presumably some have been conducted, but experiments of this sort are frequently kept confidential. The matter is exceedingly important, because, if the long modern gun is to be put out of action by the first shell that bursts anywhere near it, the value of the big gun is very heavily discounted. If a gun is to be so destroyed, then it is quite unnecessary to attempt to penetrate its protecting armour, in which case half a dozen 6in. guns would have at least six times the value of one big gun, even against the most heavily-protected battleship, so far as "beating down the enemy's fire" is concerned. This, if we speculate, gives a curious picture—a possibility of two battleships, practically intact, with scarcely a gun between them. Has a belief in the efficacy of a shell anywhere near a gun anything to do with the fashion in which the ram has again come into favour?

THERE is nothing new in the theory of attacking the big guns' muzzles, and much time and ingenuity have been expended in attaining loading positions, such that the guns may present a target only at the moment of firing; but the chances of a gun being actually hit are small. The chances of a shell bursting within a few feet of the muzzle are not by any means so small. If the theory is correct, then we have the curious reflection that all protection to the men is so much protection taken from the gun; in other words, the keeping out of a shell from passing through the battery, inside which it might or might not burst, means the almost certain destruction of the gun muzzle. And, viewed in this light, the Rossia, with her tremendous unarmoured battery divided up by screens, becomes a more logical vessel than the armour-coated Garibaldi, and still more logical than the Jeanne d'Arc, Terrible, Diadem, and so forth, all of which provide the maximum safety to the men; and the old muzzle-loaders on the main deck of the Alexandra become pregnant with defensive capabilities.

PERHAPS some of our readers know of experiments which do something to determine this question, or can cite instances of shells bursting near gun muzzles in actual war. Neither Santiago nor Yalu has given us such an incident; if any such occurred they might be kept secret—would probably be kept so. Neither of these actions, however, gives us the case of an armoured ship with long thin gun muzzles fired at at a range where missing was improbable. With modern trajectories shooting is likely to grow better, though shooting, good or bad, affects the time a battle takes more than it affects anything else. If both sides make only 2 per cent. of hits, or if they both make 50 per cent., the result to the ship attacked must be more or less the same in the end. We have not yet seen anything like equality in gunnery or ships; but given it, this question opens up a tremendous vista for entirely fresh speculations on the results of a naval fight.

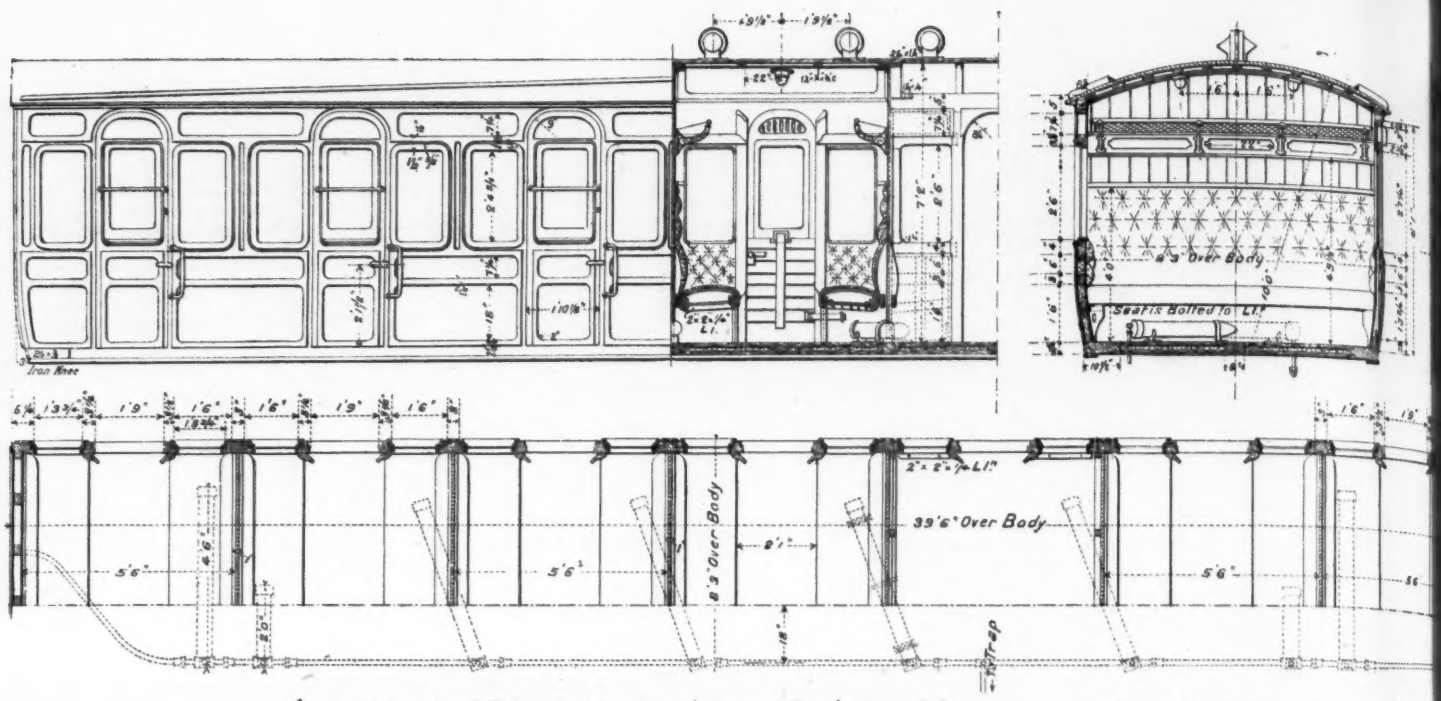
ADMIRAL HARRIS, on the Cape station, has issued a memorandum to the effect that no cleanliness of the ship at inspection, or any form of "polish" will compensate for bad gunnery. A modern cruiser action, he says, will be decided inside five minutes if fought at 2000 yards, hence the all-importance of good gunnery. The memorandum does not seem to have attracted much attention. Different admirals have variously regarded guns as ornaments, as accessories on a par with the masts, as things that make the ship in a terrible mess on those occasions when they must be fired in order to satisfy Admiralty requirements; but Admiral Harris is one of the first to elevate the position of the gun.

THE United States Navy Board has decided against the extended use of electricity on ship-board. Electric hoists, electrically-manœuvred guns, all these are wonderful labour and time-saving devices, and on them the ability to put an excessive armament in a small ship depends; it would be a very difficult thing to maintain the rate of fire in a 4000-ton cruiser carrying fifteen to twenty guns without it. But although electricity works all right at target practice, target practice in no way simulates war. When a liner is wrecked out goes the electric light, and there is a pretty prevalent idea that a shell or two bursting on board will destroy everything in the way of mechanism the least bit delicate. At any rate, electricity is looked on with suspicion to the extent of doubting its ability to survive an action. Rangefinders, sights, telephones, and all other instruments, are expected to more or less share the same fate—they did on board American warships at Santiago merely from the jar of firing. Consequently the less dependence there is on mechanism the better, for if hand has to be employed in action it is better that it should, where possible, have to be employed in practice also. Here is a case in which a very great deal could be learnt by experimental firing at a ship fitted with every possible mechanical contrivance. If this were done on two or three separate occasions a great deal would be made clear.

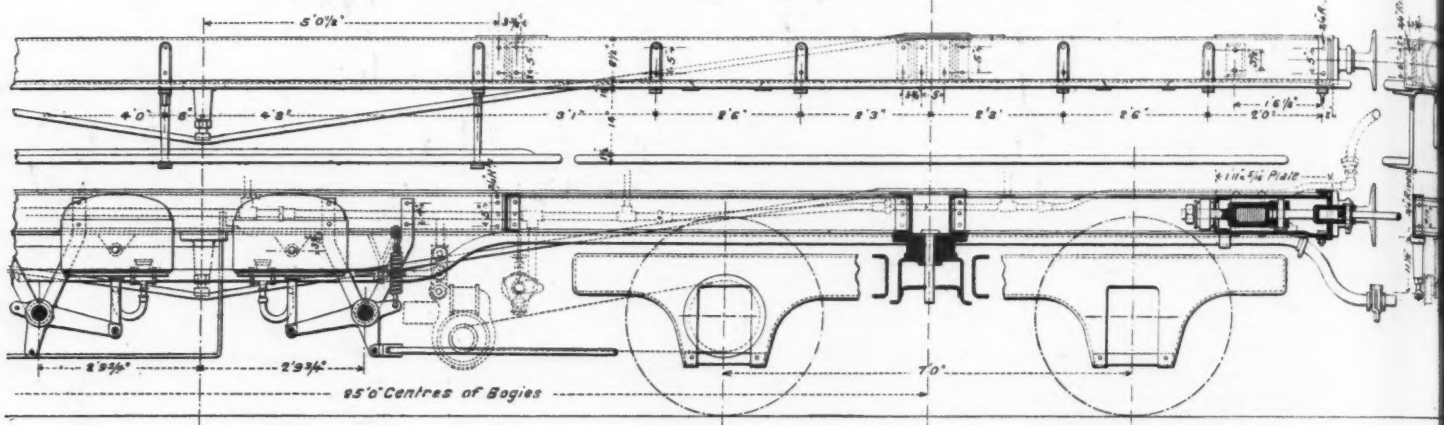
THE new ironclad London is to have the same sort of stern as the Formidable—the dead wood cut away. For manœuvring this is a most excellent thing; the trouble is likely to come when the ship is docked. Considerable care is necessary on account of the great unsupported weight—that, at least, is the objection urged. Since, however, one has never heard of any trouble befalling the Elswick cruisers, which all have the form of stern, the danger may be very small. It is difficult to see why a strongly-built battleship should be endangered more than a fragile cruiser. There is, of course, no question whatever when turning is considered; to turn eight points the Yashima has to travel quite a hundred yards less than an ordinary battleship. One can scarcely realise on paper all that that entails.

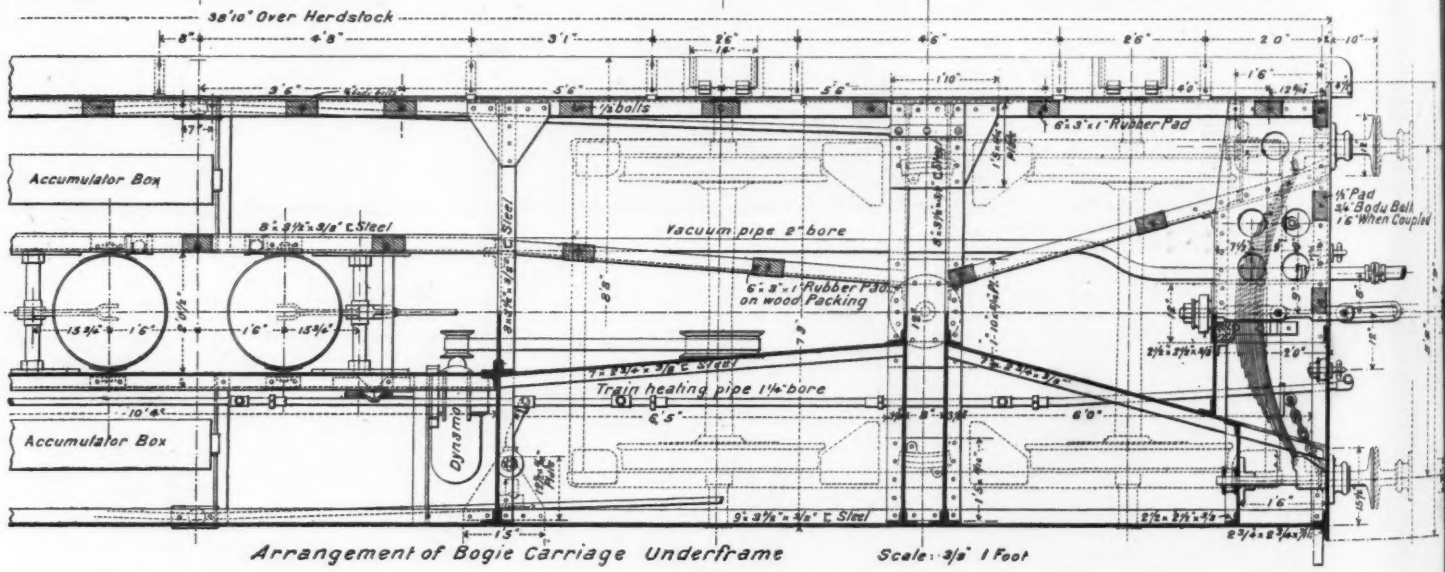
NEW COACHES, MET

THE ASHBURY RAILWAY CARRIAGE AND IR

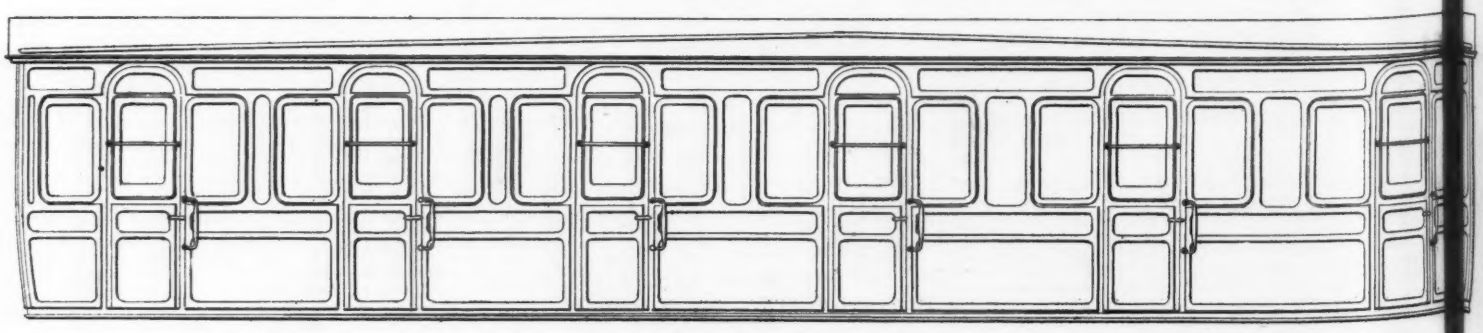


Arrangement of Third Class Carriage (Bogie Underframe) Scale 1/4"=1 Foot





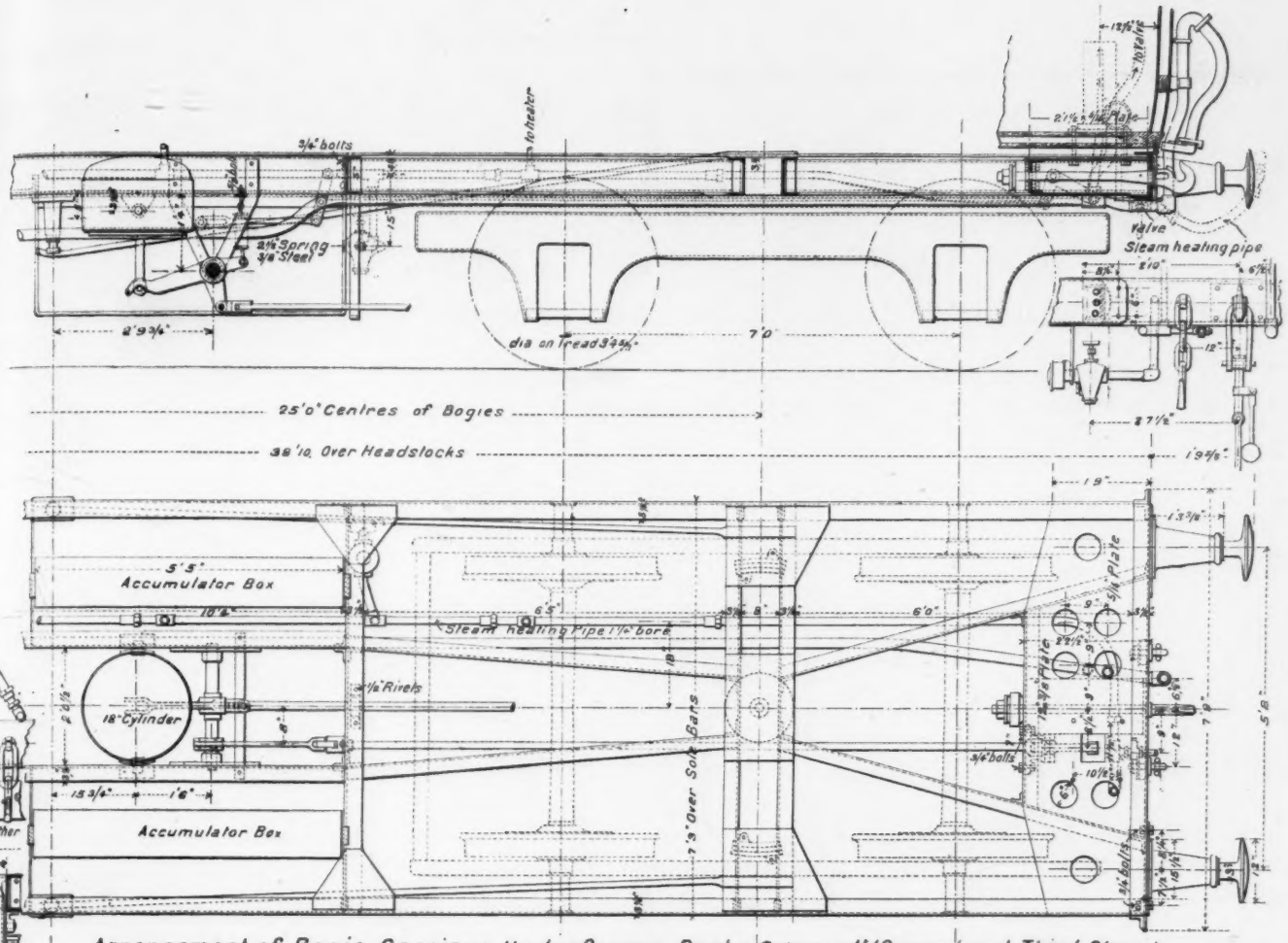
Arrangement of Bogie Carriage Underframe Scale: 3/8" 1 Foot



Arrangement of Composite Carriage First and Third Class Scale: 1/4"=1 Foot

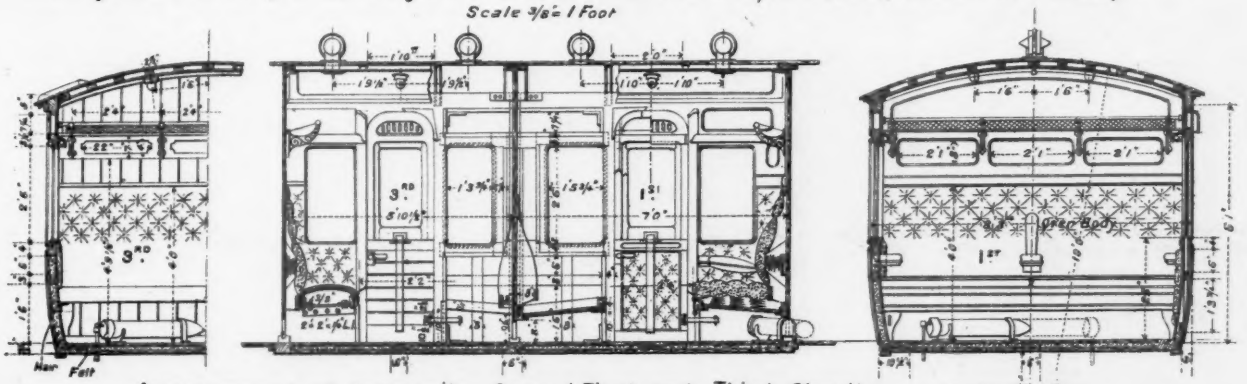
METROPOLITAN RAILWAY

GE AND IRON WORKS, LIMITED, MANCHESTER, ENGINEERS



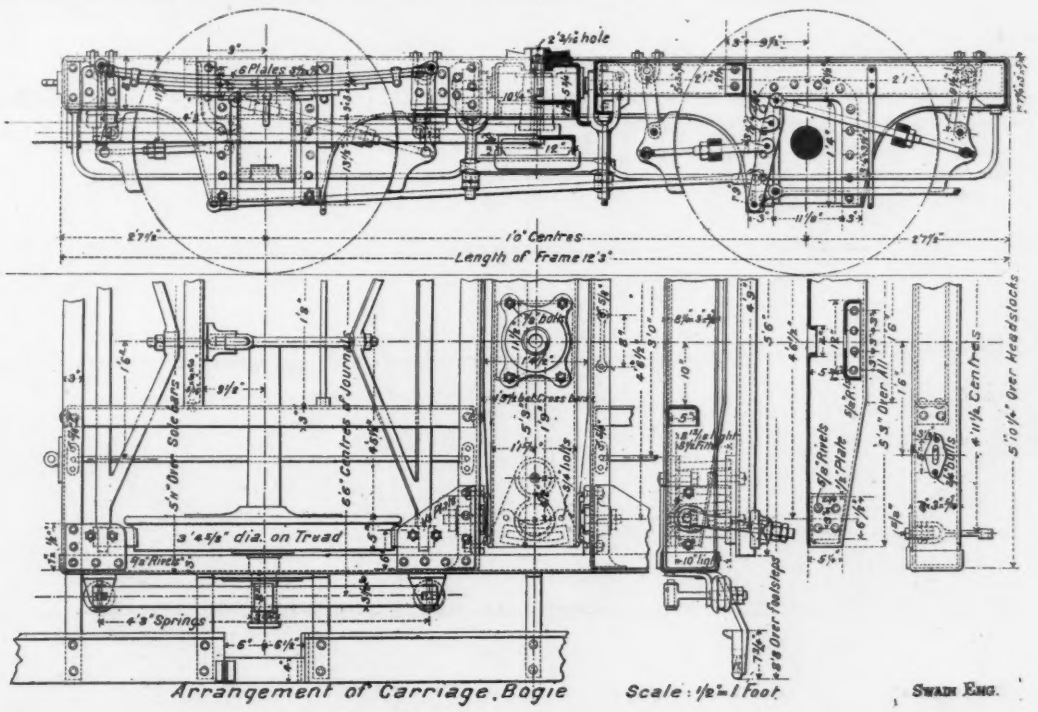
Arrangement of Bogie Carriage Underframe Brake Compart.t (Second and Third Classes)

Scale 3/8" = 1 Foot



Arrangement of Composite Carr. (First and Third Class)

Scale: 1/2" = 1 Foot.



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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

S. W.—We have fully dealt with the subject matter of your letter on this page.

VIATOR.—The paragraph is simply another example of the technical incompetence of the average newspaper reporter.

BELLEVILLE.—You will find large illustrations of the boilers in our issues of November 11th last and of October 2nd, 1896. We have printed articles upon them on many occasions. See pages 201, 307, &c., of vol. lxxxv.

E. L. (Huddersfield).—We cannot recall the name of any book that would help you much. Reynolds' "Stationary Engine Driving" (Crosby Lockwood) is perhaps the best. Wilson's "Treatise on Steam Boilers," fifth edition, by same publishers, would also probably be useful to you.

J. H. N. R.—We gather from your letter that you have just the same opportunities that we have for acquiring information. Under the circumstances we decline to express any opinion concerning the merits or demerits of the invention. We know nothing whatever about the patents referred to in the latter portion of your letter.

INQUIRIES.

MACHINE FOR STRAIGHTENING STEEL STRIPS.

SIR,—Can any reader give me the name of the makers of a machine for straightening steel strips by tension? J. N.

SMALL CUPOLAS.

SIR,—Will any reader kindly give me the address of makers of cupola furnaces for melting cast iron, for a small ironfoundry?
Cork, December 1st. A SUBSCRIBER.

HEATING FEED-WATER.

SIR,—I want to know whether there is in use—with maker's name—an arrangement for returning the exhaust steam from a steam donkey feed back into the suction pipe through a cone, which will help to increase the temperature of the feed-water.
Grace-church-street, November 31st. H. P.

COMPRESSED PAPER HOUSES.

SIR,—Can any of your readers inform us as to where we might get prices and particulars of building materials for portable houses of compressed paper? This inquiry is from friends abroad, whom we would like to oblige by obtaining the information for them.
Glasgow, December 7th. J. McN.

WIND STRESS ON IRON CHIMNEY.

SIR,—Can any reader inform me where I can get particulars to calculate the strain on the bottom flange of a wrought iron chimney, ⅜in. plates, 60ft. high? The top 40ft. exposed to the wind being 2ft. 3in. diameter, and the bottom 20ft. being 2ft. 9in. diameter and sheltered; also the number of bolts, ¾in. diameter, required to take the strain, if no guy chains are used.
Derby, December 5th. W. J. C.

MEETINGS NEXT WEEK.

THE INSTITUTION OF JUNIOR ENGINEERS.—Saturday, December 17th, at 11 a.m., visit to Messrs. Yarrow's Works, Poplar, by the special permission of Mr. A. F. Yarrow.

THE SELF-PROPELLED TRAFFIC ASSOCIATION, LIVERPOOL AND DISTRICT CENTRE.—Monday, December 12th, at 8 p.m., at Royal Institution, Liverpool. Discussion on "The Judges' Report on the 1898 Trials, and the Conditions for the 1899 Trials," to be opened by Mr. Anthony G. Lyster, M. Inst. C.E., and Mr. John A. Brodie, M. Inst. C.E.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 13th, at 8 p.m., Ordinary Meeting. Paper to be discussed, "The Ventilation of Tunnels and Buildings," by Mr. Francis Fox, M. Inst. C.E.—Friday, December 16th, at 8 p.m., Students' Meeting. Paper, "The Kentish Town Widening, Midland Railway," by Mr. Walter Daniel, Stud. Inst C.E.

SOCIETY OF ARTS.—Monday, December 12th, at 8 p.m. Cantor Lectures. Four Lectures on "Acetylene," by Prof. Vivian B. Lewes. Lecture IV.: The combustion of acetylene—Acetylene burners—Smoking and carbonising of burners—Burners for heating—Acetylene for gas engines—Diluted acetylene and its applications.—Wednesday, December 14th, at 8 p.m. Ordinary Meeting. Paper, "Commercial Education," by Sir Albert Rollit, LL.D., M.P.

THE ENGINEER.

DECEMBER 9, 1898.

SMOKE.

A SOMEWHAT futile meeting has been held this week at the house of Mr. Verney in Onslow-gardens, to carry out a suggestion made by Sir W. B. Richmond, that a society should be formed to suppress the smoke nuisance. For some weeks too a correspondence, which cannot be called a discussion, because the correspondents are all in accord, has been proceeding in the *Times*. The subject is smoke nuisance. There is nothing new about this literature, and we should not refer to it were it not that it in some sense strengthens the hands of a few metropolitan magistrates who are inflicting fines right and left for breaches or alleged breaches of the law. The electric light companies seem to be singled out for special reprobation. Under the circumstances it is worth while to state a few facts very plainly. If they were known as well as they ought to be, innocent people would be spared a good deal of trouble and vexation.

To begin with, we would direct attention to the origin of the present outcry. It took its rise in the Welsh coal strike. The substitution of a North-country bituminous coal for the anthracite fuel of Wales was followed by the evolution of a great deal of smoke from chimneys which had heretofore given no offence. Nothing could more clearly demonstrate the truth that no satisfactory means of burning bituminous coal without the evolution of smoke has yet been invented. From the days of Queen Elizabeth to the present moment, attempts have been made to achieve what is impossible. It is not too much to say that many hundreds of inventions have been patented, and many thousands of pounds spent in the endeavour to burn bituminous coal without smoke, and up to the present moment no one has succeeded. We say this while we are perfectly cognisant of the fact that North-country coal is burned every day and all day long, and not a vestige of smoke escapes from the chimney. In Leeds, chimneys may be seen, the caps of which are ostentatiously coated with whitewash to direct attention to their immaculate purity. This in no way affects the accuracy of our statement. The conditions under which North-country coal can be burned without smoke are comparatively rare. They do not exist at all in the case of electric light stations, steamships, ironworks, or domestic fires, and there is no reason to think that the necessary conditions can be secured save at a far greater cost than the great cities of this country are willing to pay. At the best of times, when the engineer and the chemist are given free hands, it is very difficult to burn bituminous coal in such a way that it will not give off smoke. The conditions as regards steam boilers are that the boiler should be of such ample power that the fires never need forcing, and the demand for steam must be so constant that the dampers need never be touched. Conditions such as these obtain in cotton and weaving mills. Fairbairn cites an engine which ran so regularly that a belt from the crank shaft drove the hands on a clock dial on the wall of the engine house, and these hands were never, it was said, more than a few seconds wrong during the working day. Such uniformity of running was concomitant with clockwork regularity in steam production. An automatic stoker, such, for example, as Jukes' travelling grate, could be used with such effect that the coal might be burned with strict regard for the laws of chemistry; and we may add that in all probability the economic evaporation of the boilers was low because an excess of air was admitted to the furnace and flues, and the whole arrangement was liked, mainly because it permitted a coal worth about 3s. a ton to be used. The rate of combustion would not exceed 8 lb. to 10 lb. per square foot of grate per hour. Now, conditions such as these do not obtain in electric light stations. It is not nearly as well known as it ought to be known that in a station with engines of, say, 3000-horse power, that power will not, as a rule, be required for a longer period than about ten minutes, the duration of that which is known as "the peak of the load." To provide for the demands just then the fires must be forced. Besides, the requirements of the engines vary continually throughout the twenty-four hours, and this renders uniformity of firing absolutely out of the question. We may say here that mechanical stokers have been tried, and are in use with success to a limited extent in electric light stations; but in all cases they are supplemented by hand-fired boilers. In steamships it is well known that the prevention of smoke is well nigh impossible. It is quite useless for magistrates and patentees and smoke experts to assert that smoke is a preventible nuisance. It can only be prevented under conditions which are quite well understood, and which are impossible of attainment in great towns. The way out of the difficulty is to burn smokeless coal. When that cannot be had the community must put up with the smoke nuisance, or pay a long price to get rid of it. The electric lighting companies have not, as a rule, space enough to put down more boilers, and every attempt to obtain more is hedged round with difficulties which we need not stop to recount. The proper course is not to try to do that which is commercially impossible, but to construct power stations far enough away in the country so that smoke will not awaken a protest from a busy and luxurious community.

Those who have written to the *Times* have by no means confined themselves to denunciations of manufacturers. The crusade against the domestic hearth has once more set forth. We have read for the twentieth time the arguments of the anthracite man, who tells the world that salvation is to be found in Wales, and in it alone; we have the closed stove man, and the steam from central stations man, and the man who would wash the smoke, and the man who would make our house chimneys open into the sewers. It is the old, old story, and we feel some sense of shame in repeating the trite and well-worn statement of fact which sets at naught all these suggestions. Unless we have fogs domestic smoke causes so little inconvenience that no one writes to the *Times*, or if they do their letters are not published. When the fog comes we all grumble. To get rid of the dark part of the smoke nuisance it is necessary, first of all, to introduce and carry through a complete domestic revolution; in a word we must abandon once and for all the open fire. There is no alternative; anthracite is quite unsuitable for domestic use. The British householder likes a fairly large slow-burning fire which demands little attention. Anthracite can only be burned full blast or not at all. Many years ago a very ingenious anthracite man produced a stove with a small grate in the focus of a copper parabolic reflector. It was magnificent; but it was not at all what the English man, or, what is more to the purpose, the English woman, wanted. The open fire and bituminous coal were made for each other. They are to the last degree popular institutions, and it will be many a day before we shall be content in this temperate climate to adopt steam, or hot water, or close stoves, or anything but the open fire, which is endeared to us by a thousand associations, and is, smoke or no smoke, infinitely the most healthy way of warming our houses and towns. That it is possible to devise arguments deduced from practice in Russia, or New York, or Berlin, or Vienna, is not to the point; we have no necessity to resort to the expensive measures necessary to keep the people of other nations warm. The Gulf Stream plays a most important part in the domestic life of this country.

To repeat an old statement, in the hope that it may be of use, let us suppose that the domestic fire was absolutely smokeless, it is by no means to be concluded that we should not suffer in a fog. If any of our readers have the opportunity and the will, they can see for themselves that dwelling-house chimneys give off very little smoke—no black smoke whatever. In the first place, combustion is fairly complete because of the large excess of air. In the second place, our chimneys are admirable soot traps. The quantity of carbon sent into

the air is very minute, but a little of it goes a long way in developing a fog. But the carbon is, after all, not that which afflicts us most; it is the sulphurous and carbonic acids which sting our throats and produce headache, and the more perfect the combustion, and the more smokeless our fire, the greater will be the quantity of these objectionable gases that pollute the air. We do not think it is necessary to do more than refer to CO, for that gas is, very fortunately, not much in evidence. It follows that all claims for grates and stoves based on the perfect combustion idea are scientific frauds, as far as the suppression of the fog nuisance is concerned.

Thus we come back to a position which may be very simply stated. To be free from smoke a city must have no factories, and no open fires. For at least half a century the most able and enthusiastic men have struggled to find a way out of this, and they have not succeeded. Is it worth while to have cities without factories? Could we have them if it were? Is the smoke nuisance so great an evil that we are prepared to give up our open fires to get rid of it? It is vain to argue that improvements may be effected which will leave us our open fires and our factories and a clean sky. Perhaps when they come we shall be able to express an opinion concerning them. Our readers have an opportunity of judging what an ideal London would be. It has been supplied them by Mr. Frederic Harrison, who delivered a lecture on the subject at Toynbee Hall on Saturday. Mr. Harrison's London will have only 2,000,000 inhabitants. It will not be, as it is now, the centre of the financial and commercial world. "In ideal London the Thames would run as clear as at Henley, and again it would be the great highway of traffic. The bridges would be doubled in number, and the disfiguring railway bridges would have to be suitably treated. Steam engines would probably be prohibited within the city, and the air would cease to be polluted by the poisonous fumes of millions of chimneys. It is really strange how long we have allowed preventible nuisances to choke us. A pure and unlimited water supply would be carried through great aqueducts, as in Rome, from inexhaustible lakes and reservoirs." All this and much more is a pretty excursion into dreamland, and after all we think that most of our readers will join with us in saying that Ideal London might easily be a very terrible place in which to live. Happy, by the time it is called into existence the Londoner will be a different being, adapted to his novel surroundings, and content to live in great blocks of buildings, with common libraries, baths, and playgrounds.

OUR NEW QUICK-FIRE GUN.

There has been keen correspondence lately in the daily papers as to the question of a reported new 7·5in. quick-firing gun. While this piece is still in embryo is undoubtedly the time for discussion if any good is to be done. The introduction of a new calibre is regarded with dismay as involving new complications, some suggest the adoption of an 8in. gun; some think the present 6in. sufficiently powerful. Under these circumstances, a few words on the subject may be desirable.

At the present moment the gun on which we all depend in action is the heavy quick-firing gun which fights behind armour of medium thickness. Speaking generally, a typical battleship's primary or heavy guns possess about half the energy of fire per minute of her heavy quick-firing guns. In the Majestic class, Charlemagne, and Poltavar classes, this is the case. As, however, the heavy guns are generally all capable of being directed on any enemy, and only half the quick-firing guns, we may consider the available energy of each as about equal; but in the heavy guns it takes the form of one blow to ten of the quick-firing pieces. The former may undoubtedly produce a crushing decisive effect on the vital parts of an enemy, but the latter is more to be relied on, and on the lighter parts of a ship ten centres of explosion are better than one of more than ten times the power. We have seen in the battle of Santiago how rapidly ships may be destroyed by the action of shells on their upper structure. Clearly, at the present moment, then, quick-fire is of primary importance. By quick-fire we mean that of the heavy and protected quick-firing pieces, because it is probable that the light and comparatively unprotected pieces could not be manned in severe close action, and even when available their fire is probably more suited to the attack of men in unprotected places than to the incendiary and other structural effects which tell most in action. The selection of our heavy quick-firing gun, then, is of vital importance. The elements governing our choice are mainly (1) power to destroy the structure we attack, (2) speed of delivery. We put them in this order because this first consideration is imperative, the second is opposed to it, or is in inverse relation to it, but it comes in as soon as the first condition is fulfilled. That is to say, once fix the necessary standard of No. 1, and No. 2 forbids going any further. Let us see what the standard of No. 1 depends on. Clearly on our enemy's structure. We want to destroy her quick-firing batteries and her conning tower and set her on fire if possible. If we can bring down her masts or destroy her steering gear and her arrangements for the supply of ammunition, or even cut her funnels, &c., about, it will, no doubt, further help matters. Ships that have all the armour they can carry applied in the form of a belt from end to end, and patches over gun positions, generally give many openings to the entrance of very light shells, but generally our quick-firing projectiles will fail even at the present moment unless they can perforate 3in., 4in., or 5in. of ordinary steel, and this at a considerable angle.

Our 6in. guns are quite equal to this. Now, however, improvements in armour plate have come in, and other nations seem inclined to increase their protection. We have long protected the 6in. quick-firing guns of our strongest ships with 6in. armour. Foreign Powers may do the same, and this, if hard faced, becomes altogether too strong for our 6in. guns; it is necessary, then, to contemplate the introduction of a heavier and more powerful piece. Elswick, which led the way with quick-fire, took the lead also in applying the principle to large calibres. Published tables of quick-firing guns may prove misleading, because some elements of quick-fire are now embodied in the heaviest guns, and some makers put such pieces down as quick-firing guns, and thus the whole subject becomes masked. As a matter of fact, Elswick first designed and brought out quick-firing guns proper, introducing 30-pounders, and proposing 70-pounders to replace all the lighter ordnance of secondary batteries on board ship as early as 1886, and equipped cruisers for Chili and other countries carrying 8in. quick-firing guns long before the principal Naval Powers of the world contemplated such pieces as coming within practical consideration. The 8in. projectile weighs 250 lb.; the gun discharging it rapidly must have very complete and trustworthy machinery provided. Here, again, must be commended the practical treatment given to the subject by Elswick. If we turn to the tables supplied by Elswick to the *Naval Annual*, we find rates of fire obtained at sea, and note that on board the Blanco Encalada four rounds were discharged from the 8in. 15·5-ton quick-fire gun in 62 seconds, the ammunition being supplied from the magazine. This seems very much to the purpose. The power of perforation of this piece at the muzzle is 26·4in. of iron. This would mean probably 20in. at 1000 yards, or perhaps 9in. of Krupp process steel direct, or 6in. at about 30 deg.; so that at the present moment it would probably need an 8in. gun to attack one of our heaviest line-of-battle ship's quick-fire guns, and that at closer range than 1000 yards, to have any reasonable prospect of success. Surely it is high time that we had a quick-firing gun of this power, for we must reckon on an enemy sooner or later having the armour we carry, and we certainly should be able to perforate our enemies' armaments of secondary quick-firing gun batteries, and not be reduced to hope for chance effects against conning tower and other structures, or even to setting an enemy on fire, for we must expect that, following the example of Germany, all navies will get rid of wood on board their ships. America has already decided to do so. From all this, then, it appears that a piece equal in power to the Elswick 8in. quick-firing gun is a necessity. Is it wise then to contemplate obtaining this in one of 7·5in. calibre? The Elswick gun obtains the perforation we have mentioned by two alternative means, either with a 250 lb. shot discharged with a muzzle velocity of 2480 foot-seconds, or with a 210 lb. shot with 2650 foot-seconds velocity. Can we obtain the same with a 7·5in. projectile? We greatly doubt it. Possibly we may approach, or even reach, it with a brand-new piece, but how long will the power be retained?

We think then that we are only asking for the lowest standard which provides for the effectual attack of the quick-firing batteries of an enemy. Few, indeed, of them at present have 6in. of armour, and long may it be before this armour is Harveyed or Krupp process plate, but after all it is a mere question of time. We have taken a range under 1000 yards, an angle of impact of 30 deg., and a new gun, and it may be seen under these favourable conditions that the 8in. gun is barely sufficient to give hope of a good result. Is it wise to contemplate a 7·5in. piece? What are its advantages? The shell is easier to handle, no doubt, but what satisfaction is this if it will not perforate our enemy's armour when it is fired?

We submit that this question needs a thorough practical investigation before we introduce a new calibre, an entirely new gun that may end in earning the unenviable distinction of being just a little too weak to get through the armour that before long it may be called upon to attack.

SCREW PROPELLERS.

It may have occurred to our readers that the inventing or designing of marine propellers has gone out of fashion. The world of shipping is no longer distracted with the claims of rival screws. The jet propeller has not been even heard of outside lifeboats for some years. Possibly engineers have at last arrived at the conclusion so often enunciated, that while there is a better screw than any other for every ship, there is not 10 per cent. between the best and the worst—in reason—that can be fitted to her. The diameter, surface, and pitch that ought to be given are well known for every case; the result is, that all twin-screw fast steamers are, almost without exception, fitted with modified Griffiths three-bladed propellers. Tramp steamers have sometimes three blades, sometimes four, very rarely two blades. The large, original Griffiths boss is seldom seen; the boss, as a rule, is kept as small as is consistent with the secure fixing of the blades. There is very little difference between the forms given to the blades; and, such as it is, it does not appear to have any appreciable effect on the speed, power, or coal bills. The principal points to be attended to are that the propeller shall be sufficiently strong; that it shall be very smooth and sharp; that it shall not be so large that it locks up the engines, and prevents them from exercising their full power, or so small that the slip is excessive. When the marine engineer has satisfied these conditions he may rest content, and listen with equanimity to the animadversions of those who tell him that they could put a knot an hour on his ship, the consumption of coal remaining unaltered.

We scarcely go too far when we say that screw propellers are bought under much the same conditions as shoes or coats. We want something that will fit the ship, be strong and serviceable, and not cost too much money. Scientific refinements of form, and elegant mathematical curves, based on still more elegant mathematical disquisitions, are no longer heard of. They may, of course, turn up again. This very article may drag some of them into the light, or suggest his opportunity to some inventor. The propeller as it is has crystallised out of a mother liquor of mathematics, mechanics, and progressive speed trials. Nine screws out of ten are probably as good as can be, or need be, and no one knows whether the tenth is equally excellent or no. So much for form of blades and proportions. Can we be equally certain that we have got the best material and the best method of construction—things which, of course, have nothing at all to do with the mathematics of propulsion? There are three materials available—cast iron, steel, and some of the brasses or bronzes or gun-metals, the base of all these alloys being copper, with which is combined zinc or tin or aluminium, with small quantities of other metals, in certain cases phosphorus being used, in view of the important part which it plays in giving clean and sound castings of alloys containing much copper. The first of these is still greatly in favour for tramp steamers. Their engines run at slow speed, seldom much over sixty revolutions per minute. There is plenty of space for a big heavy propeller, of about 15ft. pitch. It is easy to make the blades thick and strong, and such a screw comes cheap. No doubt it wastes power, and is liable to corrosion and pitting, and it is not easy to get a sound casting with certainty, but on the whole for slow speeds cast iron answers very well. A cast steel propeller is better in every way save one. It can be made with much thinner, sharper, and smoother blades, and will still be stronger than the cast iron screw; but, unfortunately, the steel propeller is liable to attacks of corrosion of the utmost virulence. Now and then we meet with a steel screw which has entirely escaped; at others we come across steel propellers utterly ruined in two or three months. It would seem that in some cases at least the propeller escapes at the cost of the ship's stern, while in others matters are reversed. Even with the use of zinc anti-corrosion plates on the sternpost, steel is too risky a material to be trusted for propellers. There remains then the copper alloys, and these are so easily first, and so much better in every way than iron or steel, that they would be used exclusively if it was not for their considerable cost. This extra cost is due partly to the comparatively high price of copper and tin, and partly to something else to which we wish to direct particular attention.

It has long been the practice to make what may be termed the better class of propellers with detachable blades; that is to say, there is a large boss keyed on the shaft, and to this the blades are secured by flanges, bolts, and keys. There are certain advantages about this mode of construction. One is that a blade can be replaced without docking, by bringing the ship down by the head and raising her stern; or, if this cannot be done, the new blade may be bolted on by a diver. Again, when corrosion attacks steel blades they can be readily replaced without the often tedious, troublesome, and always expensive operation of drawing the tail shaft and fitting on a new propeller. But these indisputable benefits are not to be had for nothing. The built-up propeller is very much more expensive than one which is a single casting. It is also much more liable to accident through the shearing of the bolts, for example; and it is beyond question that the efficiency of a built-up propeller is not equal to that of a plain propeller, the hub or boss with its appurtenances offering a good deal of resistance at once in rotation and to passing ahead through the water. For a long time it was held that big bronze castings cannot be had sound, and so bronze propellers were built up. No one believes this in the present day. If bronze is used there does not appear to be any general necessity for building up propellers, save in a few exceptional cases. The cost of the cast propeller ought to be from 20 to 25 per cent. less than that of the built-up screw—perhaps a little more, but we like to be on the safe side—while the weight of the solid casting must, we should say, be nearly one-third less than that of a loose-bladed screws, and this, be it remembered, without any sacrifice of strength; indeed, the thickness of the blades will remain the same in either case. The argument against the solid propeller is, that if a blade is broken off the screw is ruined, and that large screws cannot be cast sound in this way. The first argument possesses no force. Modern alloys are so excellent that the blades may be twisted almost into knots, but they will not break, and they can in almost all cases be straightened or bent by the aid of jacks and bears. This can be done at least once, and has, we understand, been done more than once with some of the alloys with success. The objection that large screws cannot be cast sound had at one time some force in it; it has long lost it. A visit to the foundry of any of the bronze-making firms will settle the matter. For example, the Bull's Metal Co., of St. Mary Axe, has cast a solid propeller which was 17ft. in diameter and weighed 5¾ tons. Nor, we take it, is this the limit. We venture to say that shipowners may resort to copper-alloy propellers made in one piece; and that they will find the result quite satisfactory.

What we have said of propellers is in the main applicable to paddle wheels. Invention has long ceased to interfere with them. Out of Morgan's original idea has developed a type of paddle-wheel which is eminently adapted to the Channel, or shallow water service. The special feature of the modern as compared with the old wheel is the substitution of steel-curved "floats" for the old wooden "paddle board," with which substitution the late Mr. Stroudley had very largely to do. The wheels, too, are made much more strong than used to be necessary. This is, of course, a consequence of the great power now transmitted through them; the diameters of the wheels still remaining about what they were thirty years ago or more.

Possibly some of our readers will hold that an article dealing with propellers must be incomplete if it does not touch theory in some way. By way of satisfying a not unreasonable demand, we would suggest that some one who understands the subject would explain how it comes to pass that the net work of the screw and the paddle-wheel is about the same, although they are so widely different in their mode of action, and that it appears to be just

about 50 per cent. of the indicated horse-power. We have never yet met with a theory which is alike satisfactory for both screw and paddle. After we have deducted the loss by slip common to both, much which is not common to both remains to be accounted for.

THE RAGE FOR CHEAPNESS.

A CHANGE appears to be coming over the cutlery and general hardware trades of the country which has not received the attention it deserves. It has been the boast of some of our British firms that they would not make an inferior quality of goods, preferring to lose certain markets rather than turn out wares which they considered were not workmanlike. It is in this direction the German and American manufacturers, who have successfully systematised the production of large quantities of certain goods by means of machinery, have been able for years to command certain sources of trade which have practically been closed to British firms. It was thought by people at home that the rage for cheapness would be short-lived. They have been mistaken. The demand for lower-grade goods, instead of diminishing, has gone on increasing, and many of our Midland manufacturers have at last come to the conclusion that as there is a big market for these lower-priced wares, they had better make up their minds to provide them. This has been done, and no little success has attended the efforts of the firms who have been enterprising enough to take up the trade. In various classes of tools, cutlery, and hardware, as well as in plated and metal spoons, forks, and similar goods, machinery has been freely laid down, and the prices at which the finished articles have been put upon the market are bringing a good deal of the trade to the Sheffield and Birmingham districts. What the result may be in the end is hard to say. The fear of the Sheffield manufacturers was that if they produced wares which did not stand the test of time their reputation for honest, workman-like production might be lost. On the other hand, the cheaper goods are candidly stated to be of a lower grade, and the customer would be unreasonable indeed if he expected to get for a very small sum work which could not possibly be produced at less than double or treble the price. It is significant, however, of the drift of the times to find that even in Sheffield, where the greatest possible pride has been taken in producing nothing but high-class goods, it should have been found necessary in the extreme rivalry and keen pressure of foreign makers to meet them with their own weapons, and produce the secondary grade of articles in order to meet the all-prevailing demand for something showy at a low price. Many of the older heads in our large manufacturing establishments regard the change with much misgiving, but at the same time it has been generally felt that it was bound to come, and now that it has come it is just as well that it should be energetically entertained. The cutlery trade is peculiar, and things are admissible in it, perhaps, which are not to be thought of in other branches of manufacture.

GOOD TRADE FOR TWO YEARS OR MORE.

ABNORMAL activity and quiet confidence are the pleasantly distinctive features of business in the important centre of which Sheffield is the heart and capital. All the symptoms point to a period of uninterrupted prosperity for two or three years at least. Peace in the coalfield, which is usually the cockpit of commerce, is assured for a couple of years, and possibly for a longer period. Relations between employers and employed in all branches of industry are better than they have been for a very long time. Engineers, boilermakers, moulders, and other workmen on whom the heavy industries chiefly depend, are having their position materially improved by reasonable advances being granted when a fair case warrants. Now and again the wages dispute bulks pretty largely in the local Press, but its magnitude is infinitesimal when one has regard to the wide field in which it occurs. Perhaps there never was a time when so much re-arrangement of work and wages was in progress without external commotion or fuss. The men are showing, on the whole, a fairly reasonable regard for the circumstances in which their employers find themselves, and they appear to be getting wiser than to insist upon excessive increases of remuneration before the manufacturers have had time, by obtaining higher rates for their finished goods, to recoup themselves for the increased cost of raw materials and other considerations which cause output to be more expensive. Another feature which makes for a gratifying period of gradually improving business is the absence of "booms." The day of the "boom" may be said to have gone by; it was, to start with, an American exotic, and was only successfully transplanted in England when means of production were limited. Now the means of production are so enormous that if exorbitant demands are made in any particular industry, a check can quickly be given. All this tends to steady trade, to induce sellers to be reasonable in not exacting the last sixpence for their materials, to make manufacturers and workmen alike come to closer relationship in settling disputed points, which, when they lead to strikes or lock-outs, simply play into the hands of the foreigner. After careful inquiry made throughout a large centre of industrial activity the conclusion come to is that, barring some grave international trouble, the trade of the country, judging it by one of its most important localities, is likely to maintain for the definite period mentioned its present satisfactory condition, with the happiest results for employers and employed, the families dependent upon them, and the general mercantile interests of the nation.

IN view of the provision of Clause 6 of the Act of Parliament recently passed at the instance of the Lancashire County Council, that a county council may, if they think fit, contribute, or join with other local authorities in contributing, to the rebuilding, widening, or improvement of any bridge in the county belonging to any railway, canal, or other company, corporation, or person, and to the widening and improvement of the approaches thereto, and that any such contribution of the county council shall be paid out of the county fund, and shall be deemed a special county purpose, the executive council of the County Councils Association addressed a circular to county councils requesting information as to whether railway companies have prohibited the passage of locomotives across over-line bridges, and, if so, whether any inconvenience has arisen from such prohibition, and had the council taken any steps in the matter; and also whether, in the opinion of the council, it would be desirable to promote a Bill applying to counties generally the principles of the clause quoted. Replies to the circular have been received from twenty-eight councils.

THE SMITHFIELD CLUB SHOW.

THE centenary Show of the Smithfield Club was opened at the Agricultural Hall, Islington, on Monday last, and closes to-night, Friday. Although the primary objects of the Club are to encourage the selection and breeding of the best and most useful animals for the production of meat, or, to quote the words of the founders of the Club one hundred years ago, "to supply the Cattle Markets of Smithfield and elsewhere with the cheapest and best meat," it is chiefly known by its annual exhibition, which in the metropolis is looked upon as a sort of herald of the festive season closely following. But of the hundred shows which have now been held, thirty-six have taken place at the Agricultural Hall; previously for twenty years the Horse Bazaar in Baker-street accommodated it, and for thirty-three years again prior, the Club requisitioned Sadler's-yard in Goswell-street, while one year it was celebrated at Barbican, and the first six exhibitions were held in Dolphin-yard, Smithfield. From two small groups of cattle and sheep, without division of breeds, the exhibition has grown to one of 94 classes, containing about 1200 animals, not including table poultry, while the display of implements and machinery has come to be looked upon as second only to that at the Royal Agricultural Society's annual exhibition. At the time of the first Show in 1799, the institution was known as the Smithfield Cattle and Sheep Society—the present title not having been adopted till 1802. It had 113 members, and gave prizes amounting to the sum of £52 10s.; in 1839 there were 213 members, and £300 was offered in prizes, while the enormous growth of this typically English institution at the present may be best gathered from the facts that there are now 1120 members, and £5000 is offered in prizes for live stock.

In the implement and machinery section no inducement in the shape of prizes is held out, as at the Royal Show; nevertheless an excellent collection of appliances representative of the farming and stock-breeding industries is invariably got together. Last year, unhappily, the ruinous strike in the engineering trades had the effect of marring the display somewhat; not so much perhaps that a large section of the exhibitors belonged to the Federation, as that the materials which they required were unavailable. This year it is the almost unprecedented activity in the engineering trades which has robbed the Show, for in many respects the implement section does not compare with several of its predecessors. Not that the quality of the work shows any tendency to deteriorate—rather the reverse; but there is a thinness about the stands, and a general flatness due to the lack of novelties, which is more than ever apparent. Asked the reason of the thinness, several of the leading firms told us that they have experienced difficulty in producing anything at all for the Show, and that most of the exhibits were made to order, permission having been obtained from the purchasers to bring the appliances to Islington before delivery. Under the circumstances, then, not much can be said which has not previously been recorded. The genius we have looked for to liven matters up, by revolutionising some section of the implement industry, has not yet made his appearance.

Commencing on the ground floor, one of the most attractive stands is that of Messrs. Robey and Co., Lincoln. They show amongst other appliances a single-cylinder portable engine, an improvement in which is the substitution of steel brackets riveted to the boiler for carrying the crank shaft, plummer blocks, and the cylinder, in place of the usual cast iron saddle and cylinder bolted to the boiler. The plummer blocks are directly connected to the cylinder by steel tie rods, and are also connected together by a steel cross tie rod. The plummer blocks slide upon the planed guides of the brackets, so that the stresses due to the pull and thrust are taken off the boiler. The engine being thus erected upon the boiler as a whole, and having outside steam and exhaust connection, the number of bolt holes in the boiler is reduced to a minimum. By the use of the external stop valve and the external jacket feed, all concealed or inaccessible steam joints are avoided, and the durability of the boiler and engine very much increased. Messrs. Robey also show a high-speed vertical engine, fitted with automatic shaft governor acting on the slide valve direct. The crosshead of this engine is of special construction, with a steel gudgeon having a conical head, the piston-rod being secured to the crosshead by a coned end and cotter. With this construction the removal of the piston is much simplified. We also noticed an under-type compound engine and locomotive boiler combined, fitted with automatic governor and link expansion gear. This engine, we are informed, works with perfect regularity with varying loads, and is extremely economical in fuel, consuming under 2 lb. of best Welsh coal per indicated horse-power per hour.

The machinery shown by Messrs. Richard Garrett and Sons, Limited, of Leiston Works, included a semi-portable compound engine and three portable engines; the compound engine and one of the portables were fitted with the Turner-Hartnell shaft governor, and the two remaining engines with high-speed throttle valve governors. All four portable engines are mounted on high-pressure boilers fitted with this firm's well-known corrugated firebox. The threshing machine shown this year is a specimen of their light-pattern machine, which is expressly designed to work in conjunction with a portable engine. Like all their threshing machines, it is fitted with Garrett's reversible beater drum and chilled antifriction bearings. To those unacquainted with Messrs. Garrett's threshers, we feel sure a thorough inspection of this machine would create a very favourable impression. Another attraction, at least among that section of agriculturists interested in the cultivation of clover seeds, is the double-drum clover huller introduced by this firm some two years ago. By means of this machine the clover can be cobbed, drawn, and dressed in one operation. The clover is fed into a reversible beater drum, which strips off all the heads or cobs. These are dealt with in a second drum, the seed being cleansed by means of sieves and a second dressing apparatus, after which it is delivered into sacks ready for market.

Messrs. Hornsby and Sons have their usual representative display, including a portable steam engine, the Hornsby-Akroyd oil engine, and reapers, binders, trussers, and other farm implements. Messrs. Marshall, Sons, and Co., Gainsborough, whose stand is always attractive to an engineer, show a compound traction engine, a compound high-speed engine, and a horizontal Corliss engine with trip gear, amongst other exhibits. Messrs. John Fowler and Co, Leeds, who on the occasion of the last Show had to fall back upon relics of the past owing to the strike, have this year a single-cylinder ploughing engine fitted with a horizontal drum and self-acting coiling gear, a 10 horse-power double-crank compound traction engine mounted on springs, a single-cylinder agricultural engine, and a six-furrow turn-round plough for what is known as steam cultivation. During the past year several improvements have been introduced into these ploughs. The plough bodies are so constructed that they adapt themselves to the contour of the land, thus giving an equal depth of work. Skimmers and knife or revolving wing coulters are used to ensure all the top surface being turned underneath, and thus prevent the ploughs clogging, and the forecarriage is fitted with an improved ball-bearing castor movement.

The other exhibitors of portable and traction engines are: — Mr. William Allchin, Northampton; Messrs. Clayton and Shuttleworth; Messrs. Aveling and Porter, Rochester; Messrs. Brown and May, Devizes; Messrs. Chas. Burrell and Sons; Mr. William Foster, Lincoln; Messrs. Ransomes, Sims, and Jefferies, Ipswich; Messrs. Robinson and Auden, Wantage; Messrs. W. Tasker and Sons, Andover; and Messrs. Wallis and Steevens.

Messrs. Nalder, Limited, Wantage, show a new machine called a rotary bag-tie extractor and rougher out. This machine is intended as an adjunct to grain-dressing machinery. It not only takes out that troublesome pest, the "bag-tie," but extracts short straws, and other large and foreign substances, before the grain enters the dressing machine. It consists of an endless band, on which at intervals are fixed prongs or spikes, so arranged as to pass through a corresponding set of fixed prongs in the inlet. As the endless band moves, the prongs pick off the bag-ties, &c., conveying them away from the grain, which passes straight through them. The machine can be fixed to form part of the grain-dressing machine, at the inlet of set of feeding elevators to the same, or other convenient position.

Messrs. Stamford and Co., Colchester, have on view a combined seed thrasher and sheller fitted with an improved sifting apparatus. This machine is fitted with two drums, one for thrashing the cobs or heads of seed from the straw, the other for hulling or shelling the seed. All the cob is sifted, stones and other hard substance taken out, plantain and other weeds removed before passing into the hulling cylinder, thus reducing the wear and tear of the huller, and supplying a long-felt need. After the seed is drawn it is passed to the dressing sieves, where it is efficiently dealt with, the chaff being separated, freed from dust and dirt, and bagged direct. The dressed seed is delivered into sacks convenient for easy removal.

Messrs. Robinson and Auden show, in addition to a portable engine, horizontal and vertical engines, a thrashing machine, and a chaff cutter. The chaff cutter is furnished with an exhaust fan to remove dust, &c., from the chaff. They have also an engine fitted with their shaft governor, which we have before described. Messrs. Wood and Co. exhibit vertical engines, crushing and grinding mills, pulpers, cake breakers, root pulpers, turnip cutters, shredders, and chaff cutters; but though it is a fine display of these machines, there is nothing particularly new about any of them. Messrs. Ruston, Proctor, and Co. have a fine effective show, embracing a traction engine and a portable engine, also a horizontal, a vertical high-speed, and an oil engine, as well as a thrashing machine. The traction engine, which works at 120 lb. steam pressure, is a good, sound job, and the horizontal engine has many points of interest, one of which is the length of its stroke. The finish is good on all the exhibits. Messrs. E. R. and F. Turner have a large display of their corn-grinding and crushing mills, &c., and they also show a horizontal single-cylinder engine, which is fitted with the latest form of their patent shaft governor, the springs of which are now continually in tension instead of being as formerly continually in compression. Mr. James Coultas shows a number of drills, horse hoes, &c., which do not differ materially from his usual pattern. He also exhibits a manure distributor of novel design, which, it is claimed, is capable of dealing with any description of artificial manure or fertiliser. The substance to be distributed is put into a box which is pushed automatically upwards towards a circular comb-like spreader, so that an even feed is ensured. Messrs. Ransomes, Sims, and Jefferies have as usual a good serviceable-looking exhibit, which includes a large-sized road locomotive, a portable and various other engines, a thrashing machine, ploughs, haymakers, swathe turners, rakes, &c., all of which are more or less of ordinary type. They also show a potato planter of new design, which takes the potatoes separately in what are practically fingers and thumbs and drops them automatically in the right place. The Darby Land Digger Syndicate have one of their diggers, but this only differs in slight detail from the machine we described some few months ago. Messrs. Crossley Brothers, besides others, have a 16 brake horse-power self-starting oil engine. The starting is effected through a special valve by means of compressed air contained in an ordinary steel bottle, detached from the engine. This cylinder contains air at 180 lb. to the square inch, and holds enough for twelve "starts," and can be recharged by the engine itself. Other exhibitors of gas and oil engines are:—Messrs. the Campbell Gas Engine Co., Halifax; Allen and Barker, Taunton; Clayton and Shuttleworth; J. and F. Howard, Bedford; Edward

Humphries and Co., Pershore; the Trusty Engine Works, Cheltenham; Fielding and Platt, Limited, Gloucester; J. B. Petter and Sons, Yeovil; Mr. John Wallis Titt, Warminster; and Tangyes, of Birmingham.

Messrs. J. and F. Howard have samples of their portable and horizontal engines, and also an hydraulic hay and straw press. There is one hand pump to this press, but there are two sizes of plungers, the larger being used at first, and the smaller when the necessary pressure becomes greater. They have also one of their self-wiring presses, which we have previously described. Messrs. E. S. Hindley's exhibit is practically the same that we saw last year.

Messrs. Clayton and Shuttleworth's exhibit includes several steam and oil engines, &c. They have one traction engine which, when fitted with different wheels, becomes a road roller.

In the galleries Messrs. E. H. Bentall and Co. have a large exhibit, in which is one of their combined crushing and grinding mills, the hoppers of which are so constructed that the grain can be fed separately or simultaneously for both grinding and crushing. Messrs. Robert Boby and Co. show amongst other things their clover-seed cleaning apparatus, and their cellular-cylinder separators for cockle, half corn, &c. Messrs. Alfred Dodman and Co. have some nicely-finished miniature steam plants. Messrs. Kell and Co. have a manure distributor which is dependent in its action on a series of revolving stirrers, which throw the manure on to a revolving cylinder, which in its turn sends it to the ground through a shoot. In an effective exhibit Messrs. Kearsley and Co. show samples of their binders, reapers, and combined mowers and reapers. Messrs. Massey, Harris and Co. have a sheaf binder, a feature in which is an arrangement by which the ends of the straws are made to butt up against a specially-constructed board, and much neater work done. Mr. Thomas G. Slipper exhibits a mower, and claims that it is the only mower in which the "draw" actually comes upon the knife bar itself. A stay is run from the draw bar to where the knife bar pivots, and it is said that among the advantages attaching to this form of mower is the fact that the wheels are not lifted from the ground when obstacles come in the way of the knife bar.

Prominent amongst Messrs. Blackstone and Co.'s exhibits is their new swath turner, letters patent for which have been applied for. In this machine, as in the older swath turner made by this firm, the forks work at an angle to the line of draught, and have practically the same motion, although it is obtained in a different and simpler way. The two turning forks in the new implement are suspended from the opposite extremities of an oscillating beam, which works at a suitable angle to the main axle, giving the forks their necessary vertical motion. The horizontal movement of the forks is obtained by connecting each of them by means of rods attached at a suitable distance from their point of suspension to two of the pins of a three-throw crank, the third pin of which by similar means is made to oscillate the beam. The two movements described above, combined with the forward motion of the machine, result in an action of the tine bars eminently suited to turn the swathe in an efficient manner. The frame of the machine is very compact, as the working parts only require support at one point, and the whole of the movement is derived from one crank shaft, drawn by a single pair of bevel wheels. A Stamford cultivator, arranged for the purpose of general cultivation, is shown. In this form it may be used for working stubbles and clover leys at any required depth from 1in. to 5in. It covers a good width, and every inch of ground is cut. Messrs. Blackstone exhibit, for the first time, one of their new pattern horse rakes. This implement is both self-acting and manual, but if desired can be supplied as a manual rake only. It is made in three sizes, of both a light and heavy pattern, to suit every requirement. The tines can be raised on the lifting pawls, put in gear by either the hand or the foot of the driver, and can also be operated from the back of the implement. The lifting and locking mechanism is simple and efficient.

FEED-WATER HEATERS.

A MEETING of the Institute of Marine Engineers was held on November 28th, at the Institute premises, 58, Romford-road, Stratford, when an interesting discussion took place on the paper read at the previous meeting by Mr. George Halliday, on "Feed-water Heaters," reference to which has already been made in THE ENGINEER. Mr. Alderman G. W. Kidd, vice-president, occupied the chair.

Mr. W. Lawrie, who re-opened the discussion on the subject, said that in bringing this paper before the Institute Mr. Halliday had again placed the members under a very great obligation to him, and he was sure he was only voicing the feeling of every member present when he thanked the author for the very able and original manner in which he had dealt with the matter. In his opening sentences Mr. Halliday reminded them that the action of the ordinary surface condenser was somewhat in the nature of a feed heater, and most marine engineers of the pre-feed-heater period would fully endorse that statement, remembering as they did that by a judicious manipulation of the injection valve they had many times helped themselves to increased revolutions. Formerly the main idea of feed-water heating was the saving of waste heat, using gases that would otherwise be lost to them. Engineers were always alive to the fact that hot feed was a necessity for producing and maintaining high steam. How often had they had a dispute at the end of a watch about the height of the water-level in the boiler? And why did they always keep the water-level as low as possible consistent with a good relief? It was because the water necessary for raising the level in the boiler had to come from the supplementary feed at a temperature much below that of the water in the boiler, and the admission of this feed produced a serious reduction in the steam pressure. They all knew the value of hot feed-water, and why they stopped for so many years at the hot well was to him somewhat of a mystery. On the other hand, how many of them had made attempts, on their own lines, at feed heating? In 1863 he was the second engineer of a steamer running from Liverpool to Bombay, and the chief engineer of that vessel conceived the idea of running a steam pipe from the boiler into the hot well, and thereby increasing the temperature of the feed. That attempt was not altogether a failure, but it was not a success, and was discontinued. It was another illustration of the fact, however, that we were sometimes very near success without knowing it; and had they had better materials and appliances for the purposes of that experiment in 1863 there is no saying what might not have been the results. The idea of the chief engineer in making the experiment was not primarily for the purpose of heating the feed. He thought that when the natural draught was so very sluggish, as it was so often in the Red Sea, this heating of the feed-water would enable them to get better steam, and thus increase the speed of the vessel. He—Mr. Lawrie—said at the time that it was very much like robbing Peter to pay Paul, but the chief engineer replied that he would not mind robbing his own father if he could reduce the time occupied between Suez and Bombay by two or three hours. After referring in some detail to several of the comparisons set out in the paper, Mr. Lawrie alluded to the trials described by the author which had been carried out on board the New Palace steamer La Marguerite. Mr. Halliday had very fully described the experiments that were made in that vessel, but in regard to the reference by the author to the steam pressure of 105 lb. per square inch, he—Mr. Lawrie—might explain that that was a very easy full speed for La Marguerite. She happened to be on a run where full speed was not required, but, as Mr. Halliday explained, when the feed heater was used the steam kept rising, so that they had to close the dampers. When the feed heater was turned off they had to reverse the operation and open the dampers; so that by using the feed heater the advantage was, keeping the steam pressure at the same height with a considerably less coal consumption and a restricted draught. He had been somewhat surprised to read an article in THE ENGINEER, in the course of which the writer, referring to feed-water heaters generally, said, "Waste heat is not utilised in any way." Now, if by closing the dampers an engineer using a feed heater consumed less coal per square foot of fire-grate, with a very much lower rate of combustion, and still retained the same funnel temperature, he—Mr. Lawrie—maintained that there was a decided saving of waste gases. They were putting less air through the furnace, through which it passed more slowly, and there must surely be a saving of heat; otherwise where did the heat come from that produced the steam? The writer of this article said, further, that "nothing is to be had for nothing in this world, and it would seem clear that there must be a reduction of the temperature of the waste heat." But it was not suggested by Mr. Halliday that any more heat was taken out of the steam than was put into it. What Mr. Halliday did say was, that by the adoption of the feed heater a better use was made of the hot gases. Mr. Halliday showed them that in estimating the economy of the feed heater they must take into consideration not only the heat that was put into the boiler in the feed, but also that more heat was taken through the heating surfaces. The author showed that the higher the temperature of the feed the greater was the speed at which the water moved in the boiler over the heating surfaces, and the quicker did the water carry away with it the heat from the surface of the plates. In other words, when the feed was heated it influenced not one, but two things—the heat taken from the steam, and the heat taken from the hot gases. This was the explanation put before them by the author, and as it was the only reasonable theory that had been suggested, he thought they were bound to accept it.

The Chairman reminded the meeting of the suggestion made by Mr. Hawthorn, that the time was fast approaching when the present surface-condenser might be done away with altogether, his idea being that there was more force wasted in using the air pump than was gained by means of the vacuum obtained.

Mr. Lawrie said that experiments on the lines indicated by Mr. Hawthorn had been tried, and an attempt had even been made to pump the steam back into the boilers. Indeed, he believed an idea was propounded for sending a thousand-ton steamer round the world on a consumption of about ten tons of coal, but he was not aware that any attempt was ever made to give effect to this idea.

Mr. Sage said that a vast amount of ingenuity had been exercised in designing and constructing feed heaters which heated the feed by means of steam taken from the boilers, but in his opinion it was not beyond the ingenuity of the engineers of the present day to design a method of heating the feed by means of heat which would otherwise be wasted.

The Chairman thought it was apparent to all engineers that something ought to be done with the waste gases, and related an experience with a kind of feed-water heater fitted in the smoke-box. The great objection to the heater was that it stopped the draught, while the tubes after a short time became clogged, and had to be taken out. When this steamer reached her outward port, this water heater was removed, and, as a matter of fact, the ship steamed a good deal better without the water-heater than she did before.

Mr. M'Laren gave some particulars of a system which, it was stated, conduced greatly to boiler economy, and which consisted of pumping a special mixture into the boiler along with the water; but in answer to the Chairman he said he was unable to state the cost of the mixture.

Mr. Hulme described some trials with feed-water heaters, and the difficulties encountered and overcome; and after some remarks from Mr. Cook and others,

Mr. Halliday replied. He referred in some detail to the action and circulation of the water in the boiler as bearing on the question of the economy due to hot feed, and said that one advantage of using a feed heater was that less air went into the boiler with the water. Air in the water had the effect of causing pitting in the boiler. If they got rid of the air they got rid of the pitting. The feed heater also got rid of the oil, and without the oil they got a better transmission of heat through the plates. The ideal system of feed heating was that which heated the feed to the temperature of the water and steam in the boiler; and it was impossible to heat the feed up to this temperature except by means of a feed heater which used the waste gases. Live steam could not be a perfect feed-water heater. The only possible perfect water heater, from a theoretical point of view, was a heater in which the feed was heated by the hot gases.

On the motion of the Chairman, seconded by Mr. Aukland, Mr. Halliday was accorded a hearty vote of thanks, and it was announced that the discussion on the subject would be adjourned until the second Monday in December, when a paper on "Electric Lighting" will also be read.

A vote of thanks to the Chairman concluded the meeting.

LEEDS ENGINEERS' DINNER.—The thirty-third annual dinner of the Leeds Association of Engineers took place on Saturday evening, December 3rd, at the Queen's Hotel. There was a large attendance. The chair was occupied by Alderman F. W. Lawson, Professor Goodman being the vice-chairman. After the loyal toasts, the Chairman, in giving "Prosperity to the Association," said it was mainly to the engineering trade that Leeds had attained to the position it occupied. Although the engineers were all full of trade in Leeds, yet they knew they had to compete with foreigners. In 1873 he was at a dinner given to the British exhibitors at the Vienna Exhibition, and it was then said we had no need to fear the competition of any nation which allowed their women to go up ladders as bricklayers' labourers — that being the practice in Austria. At that time it was quite unusual to have in Austria any other than a British engine. Now it was quite unusual to have a British engine, and still the women went up ladders as bricklayers labourers. It would be necessary to exert all their powers to have the engineering works of Leeds and this country not only abreast but ahead of the times. After various other speeches, Professor Goodman proposed "The Engineering Trades," and Mr. J. H. Wurtzburg responded. Mr. R. Lupton gave "Our Honorary Members and Guests," which was acknowledged by Mr. J. H. Wicksteed and Mr. E. Matheson. Other toasts followed.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

BRITISH AND AMERICAN MACHINE TOOLS.

SIR,—Your leading article on the above subject is too meek and mild, and does not, in my opinion, go far enough. Like yourself, I have no object in "puffing" American tools; the only end I wish to serve is to try and arouse British toolmakers to the actual reality of their position, and this from the point of view of a user and purchaser of machine tools. You have put in a few words the real distinction between the American and British toolmakers by saying that the former do not wait for their customers to tell them what is wanted, but show them how much more and better work can be done by new over old methods. Very few cases indeed can be pointed out where the British toolmaker has done this. I am afraid, from conversations I have had with some of our toolmakers, that they despise or affect to despise both American machine tools and American methods. These gentlemen, like the ostrich, bury their heads in the sand, and won't see what is going on about them. They tell me constantly, "Oh, yes, American tools may be good enough for the cycle trade and other light work, but when it comes to general engineers' tools, where are they?" The answer, and the very correct answer, is, "That the American tools are there, viz., in general engineers' shops, &c., and are likely to increase much faster in number than British tools." You, Mr. Editor, have a sort of feeling that way yourself when you say that it is beyond contention that no finer tools of large size are made in any part of the world than in Britain. I am not so sure of that. Let us go into detail. Where can you find finer designed or better constructed boring and turning mills—sometimes called horizontal lathes—than those made by the Niles Tool Works, Bullard Company, Pond Company, &c.? In fact, such machines have not been made in this country until a couple of years ago, with the exception of Messrs. Richards and Co., Manchester, who make them only in small sizes. Those now made by one or two Manchester firms are not so well designed as the American, because of want of experience in their use and construction. Their prices are as high, if not higher than the American, and as for time of delivery, well, the least said about that the better.

What about milling machines? It was undoubtedly the Americans who showed us what the milling cutter could do, and anyone unprejudiced will undoubtedly confirm my belief, that not only in small milling machines, but in large plain or slab milling machines, they stand pre-eminent. I am well aware that there are one or two firms in this country who make such large machines, but they have not had the experience in them that our cousins across the water have, and this can be seen in the designs of their various types of those machines.

Sometime ago I wanted to buy an automatic gear cutter. I tried the only firm in this country who advertise themselves as makers of such; their price was not only higher than the American make, but they wanted nine months to deliver it, while their machine was inferior in design and construction to the American. The fact of the matter is, there is to-day no machine maker in Britain who makes a push of automatic gear cutters. Here, surely, is an opening for some one who is wide awake enough to take advantage of it.

What about capstan and turret lathes? What firm or firms in this country except Alfred Herbert, Limited, of Coventry, can show us such a line of these tools for both bar and casting work as the Americans? If some of our toolmakers would either study themselves, or appoint some one with a head and brains to study, say, the Jones and Lawson, Gisholt, Bullard, and the Dreses and Mueller capstan and turret lathes, they would find what a great saving in manufacture is caused by the use of such tools, and the wide field which is open in this country for good firms to take up their manufacture.

What about planing machines? The largest and best planes made in this country are made on the American Sellers principle, but even then they are not up to date in speed. There are no firms in this country to-day who can offer a good planing machine with a cutting speed of 20ft., and a quick return speed of 80ft. These are the lowest speeds of the American planes. Further, let anyone stand beside an American plane while it is at work, one can hear oneself speak; but let him stand beside a British-made plane, and one has to shout, so great is the noise as compared with the American. The secret is that only cut gearing properly designed is used, and notwithstanding their quick speeds all are beautifully silent. Again, where can we buy in this country planes which give the user such a range of feeds as we find in the American? With the latter you can have from $\frac{1}{2}$ up to an inch, and sometimes more than that. The broad feed in finishing cuts is invaluable, but you can't get it on a British plane.

What about horizontal boring machines? Anyone conversant with this branch will find ample food for comparison if he reads an article on American horizontal boring machines in a recent issue of *Cassier's Magazine*. I recently wished to buy one or two of these machines, and asked several British makers for prices. The type which suited us best was priced at £335. I declined to pay such a price for the machine, and tried America. The result is that I am getting a better machine delivered f.o.b. New York for £240, and delivered in one-fourth the time of the British tool. Further, a guarantee has been given—voluntarily on the makers' part—that this machine will bore and face both ends of a cylinder at one time, and that it will finish in this manner nine cylinders 10in. diameter by 12in. long in ten hours. I ask, where such a machine can be bought in this country that can do this? I know that this has been done by many American machines.

What about drilling machines? Where can anyone buy a drilling machine in this country with a movable head, as is common in the American vertical drilling machines? The head can be moved down close to the work and so support the spindle; heavier cuts and stronger feeds can be given to such a machine than if the spindle had to stand out some inches. Further, in some American drills the double gear can be thrown in and out of gear without stopping the machine—a feature which is valuable in tapping holes. A much greater range of feeds is given on the American drill than in ours, while automatic stops to the feed are quite common, but on our own tools I have never seen one fitted.

What about lathes? About the ordinary sliding, surfacing, and screw-cutting lathes, I am not such a lover of the American machine. The feature I do not like in them is the tool rest. They are made far too weak and flimsy for heavy cuts, but our toolmakers must not think that this will escape the attention of the American toolmaker. The great feature they possess is that they find out themselves the weak points of their tools, and alter or adapt them to suit all requirements. The British maker is content to wait till his customer complains or kicks up a row, and then, perhaps, the next machine he makes he will alter. There are, however, many points for admiration in the American lathes. One very desirable feature is the friction back gear. Among the whole list of our toolmakers, I know no one who advertises friction back gear to their lathes. I am speaking, of course, of ordinary lathes, not special tools such as turret and capstan lathes. Again, any one examining an American lathe will see two projecting pieces of metal on the fast headstock below the cones. These are cast on the headstock to prevent the belt slipping into the back gear and getting chewed up, which, as any one knows, is done from time to time. These simple bits of metal are nothing in themselves, but I have not seen a British lathe possess them. Further, there are only one or two firms in this country, and that only recently, that can offer you a lathe with several changes of feed to the back shaft, without requiring to use change wheels. Lang's and one or two other firms are the only ones in this country who can do this. The old style was that the turner had to hunt about for his change wheels, pull off those he had on, and put on others, and perhaps he puts on the wrong ones, the feed oftener

being too slow than too fast. Also, where can we buy a British lathe to cut a range of different threads without the use of change wheels? I answer that there is not such a lathe made in this country. You can buy these from half a dozen American makers, all of whom make a strong point of them. Lathes with automatic stops to the feed in Britain cannot be had; they are common with our cousins.

What about keyway cutting machines? So far as I am aware, there is only one firm in this country who has a line of these, and it is an American patent. The patent, I understand, is in the tool used, and not in the actual machine itself. Sometime ago we ordered one from the firm in question. The "rig out" of tools was to cost more than one and a-half times the cost of the machine. We were prepared to pay this, as we saw a saving. Nine months passed, and no machine came. We cancelled the order, bought one in America for less than one-half the price of the British machine, and it was delivered at our door six weeks after the order was given. No machine could give us greater satisfaction, both as to quality and quantity of work, than the one we have. Why do not some of our toolmakers take up the making of keyway cutters? There are practically none to be bought here. A splendid opportunity lies open here.

This letter is longer than I anticipated, so I refrain from going further into detail. I only wish to say that the British makers are living in a "fool's paradise," and that they will get a rude awakening the first slack time that comes. They are busy now mostly on our own home demands, the foreign trade—Britain's greatest trade—is being neglected, and the American is filling Europe, &c., with their splendid tools. What a difficult matter it will be to oust them, is known only to those who have attempted similar things in other lines. Go where you will on the Continent, you will find American tools having a sale before British tools. Explain it if you can. I cannot, except on the ground that they are better tools, and better brought to the people in want of them. I have been told by some toolmakers here that even if they made as good tools as the American, they could not command the high prices. That, in my opinion, is a fallacy. The one thing the toolmaker has to do is to convince the purchaser that his tool is better than any other make, and he will get his price. It is a mistake, however, to suppose that the American machines are high in price as compared with those of our own good toolmakers. I have given instances where they were cheaper, and I could multiply them.

Gas and Oil Engine Works, HUGH CAMPBELL.
Halifax, December 5th.

THE DIESEL RATIONAL OIL ENGINE.

SIR,—I have read with great interest the article which appeared a few weeks ago in THE ENGINEER on the Diesel oil engine, and also the article which appeared in your issue of October 15th, 1898. The conclusion at which I have arrived is that the use of the word "rational" in describing this engine is not justifiable, and I shall feel obliged if you will grant me the small space necessary to give my reasons for coming to this conclusion. The subject of gas and oil engines has become one of very grave importance, and there are already many who think that the days of stationary steam engines are numbered.

The engine described in your issue of November 15th, 1898, is stated to have given out nearly 20 brake horse-power when running 175 revolutions a minute. The explosive cylinder is 9·8in. diameter and the stroke 15·7in., so that the volume swept out by the piston during the compression stroke is 68 cubic feet a minute. According to the diagram it is compressed to about 544 lb. absolute. The value of γ for air lies between 1·3 and 1·4. If we assume that the pressure of the air in the cylinder before compression was 14 lb. absolute, the ratio of voluminal compression will be 16·9 to 1 if $\gamma = 1{\cdot}3$ and 13·8 to 1 if $\gamma = 1{\cdot}4$. Corresponding to a voluminal compression of 16·9 to 1, the total volume of the charge per minute will be equal to 63·26 cubic feet, and the compressed volume to 3·74 cubic feet, and to the ratio 13·8 to 1 to 64·14 cubic feet and 4·64 cubic feet respectively. According to these data, the net indicated horse-power required to compress the air, if the compression is adiabatic, will be equal to 13·7 indicated horse-power if $\gamma = 1{\cdot}3$, and to 14·4 indicated horse-power if $\gamma = 1{\cdot}4$.

The oil is not mixed with the gas until after the air has been compressed in the explosive cylinder. The oil is then forced into the compressed air in the explosive cylinder by means of air compressed to much higher pressure pumped into a receiver. The diameter of the air piston is 2·7in., and the stroke 7·8in. The air pump does a full working stroke each revolution, so that if we allow ·2in. for clearance the volume of the air at atmospheric pressure pumped in 175 revolutions would be equal to 4·62 cubic feet. This is compressed to about 725 lb. absolute before the piston reaches the end of its stroke. During the compression stroke in the explosion cylinder the air is admitted to the oil chamber directly it is compressed to 725 lb., and in consequence of this the pressure falls from 725 lb. down to nearly the maximum pressure in the explosion cylinder before the piston reaches the end of its stroke, so that the work done by the air pump during this stroke will be less than when the air is pumped into the receiver against 725 lb. pressure. I make the indicated work in both strokes to be equal to about 1·4 indicated horse-power if $\gamma = 1{\cdot}3$, and 1·7 indicated horse-power if $\gamma = 1{\cdot}4$. In the case of gas engines the difference between the indicated and brake horse-power covers not only engine friction, but also the work done in the exhaust and charging strokes, and the difference between the work done in compression and the work that would be returned in expansion if no explosion took place. This last is a negligible quantity when the initial compressive pressure is less than 100 lb. In the gas engine trials of the Society of Arts the mechanical efficiency on this basis of the Atkinson gas engine was found to be equal to 85 per cent., of the Crossley to 86 per cent., of the Griffin to 81 per cent. The work done in overcoming machinery friction would probably not amount to less than 13 per cent. even in the case of the Crossley gas engine. The mechanical efficiency of the Diesel gas engine is stated to be equal to only 75 per cent., but in this case the difference between the indicated and brake horse-power covers the work done in pumping the air into the receiver. Taking all points into consideration, 15 per cent. of the indicated horse-power cannot be regarded as an excessive allowance for machinery friction in the case of the Diesel oil engine. From the above data we get the following analysis of the work of the Diesel engine, corresponding to the values $\gamma = 1{\cdot}3$ and $\gamma = 1{\cdot}4$.

$\gamma = 1{\cdot}3$.	I.H.P.	B.H.P.
Net work done in compression in explosion cylinder	13·7	—
Net work done in compression in air pumping	1·4	—
	15·1	17·7
Net external work measured by brake	—	19·8
Gross work done in expansion	44·1	37·5
$\gamma = 1{\cdot}4$.		
Net work done in compression in explosion cylinder	14·4	—
Net work done in compression in air pumping	1·7	—
	16·1	19·0
Net external work measured by brake	—	19·8
Gross work done in expansion	45·6	38·8

It is stated that the consumption of oil per brake horse-power per hour during the trial was ·54 lb., so that for 19·8 brake horse-power the hourly consumption would be 10·7 lb. The thermal power of 1 lb. is stated to be equal to 18,370 B.T.U. If we put the B.T.U. equal to 772 foot-pounds, the value adopted by Mr. Bryan Donkin, the mechanical equivalent of 1 lb. of the oil burned per hour would be 7·16 indicated horse-power, so that the mechanical equivalent 10·7 lb. would be equal to 76·6 indicated horse-power. In the following table of heat distribution the percentages are those given in Mr. Bryan Donkin's report of October 15th, 1897. The corresponding indicated horse-power have been calculated by myself on the basis of ·75 per cent. mechanical efficiency.

Heat converted into external work	33·7 per cent.	=	26·5 I.H.P.
Absorbed in water jacket	39·0 ,,	=	30·7 ,,
Dissipated in other ways	27·3 ,,	=	21·5 ,,
Total	100 per cent.		78·7 I.H.P.

This may be regarded as in practical agreement with the thermal value of the oil on the basis that the B.T.U. is equal to 772 foot-pounds. I venture to think, however, that a heat efficiency of 33·7 per cent. is an impossibility in the case of an engine of which the mechanical efficiency does not exceed 75 per cent., and from which the exhaust gas is discharged at nearly 60 lb. absolute pressure, and that the explanation is to be found in the value of the B.T.U. adopted by Mr. Bryan Donkin. If we adopt 1000 foot-pounds as the value of the B.T.U., the thermal power of 10·7 lb. of the oil used will be equal to 99·7 indicated horse-power, and we should have the following table of heat distribution:—

Heat converted into external work	26·8 per cent.	=	26 5 I.H.P.
Absorbed by water jacket	40 0 ,,	=	39·8 ,,
Absorbed in air pumping and overcoming friction, &c.	6·1 ,,	=	6 7 ,,
Dissipated in other ways	27·1 ,,	=	26·2 ,,
	100 per cent.	=	99·2 I.H.P.

The final pressure on the eve of exhaust is about 59 lb. absolute.

The indicated horse-power required for air compressing and pumping and giving out 19·8 brake horse power, plus 15 per cent. allowance for machinery friction, is according to my calculations for the value $\gamma = 1{\cdot}3$, equal to 44·1-horse power. According to the value of the indicated horse-power calculated from the diagram on the assumption that the work given out in compression would be equal to the work given out in expansion, if no oil was added, viz., 26·7 horse-power, the total indicated horse-power would be as follows:—

Net indicated H.P. calculated from the diagram	=	26·7 I.H.P.
Work done in compressing and air pumping	=	17·7 ,,
Total		44·4 ,,

As the work given out by expansion would certainly in the case of a water-jacketed cylinder be less than the work done in compression, the work calculated from the diagram, by means of the curve of expansion, would have been slightly more than 26·7-horse power. The agreement between the results attained, however, so nearly agree that we may regard them for all practical purposes as identical. In addition, therefore, to the *vis viva* expended by the fly-wheel in producing as nearly as possible an equal distribution of the power generated in one stage through the four stages of the Carnot cycle, sufficient will have to be expended on the stage of compression alone to give out from 47 per cent. to 49 per cent. of the gross power generated on the working expansion stage. In the case of engines which do not compress the charge to more than 80 lb. pressure, which was the case with the engines tested at the Society of Arts trials, the work done in compressing may be regarded from this point of view as a *quantité negligeable*. In the report of the judges the following particulars relating to the fly-wheels of the three engines tested have been given:—

	Atkinson.	Crossley.	Griffin.
Mean periphery velocity per second in lineal feet	39	45	52
Weight of wheel per indicated horse-power in pounds	131	91	74

What must be the periphery velocity of the fly-wheel in the case of the Diesel oil engine, and its weight per indicated horse-power, in order to enable it not only to distribute the effective brake horse-power as nearly as possible uniformly during the four stages, but also to give out in one stage from 47 per cent. to 49 per cent. of the gross power generated in another stage, without entailing a greater divergence from the mean velocity than that which occurred in the case of the three engines tested.

The oil used is described as petroleum. It was, however, a distillate of petroleum of the following composition:—Carbon, 85·13 per cent.; hydrogen, 14·21 per cent.; oxygen, 0·66 per cent.; total, 100 per cent. It was, therefore, a pure hydrocarbon oil. It is quite right to describe petroleum as a hydrocarbon oil, because its principal constituents are hydrogen and carbon, but we are not justified in describing a pure hydrocarbon oil as petroleum for two reasons. Firstly, because it is not petroleum. Secondly, because it can be obtained from other sources than petroleum. The makers of the Hornsby-Akroyd oil engine claim to get a brake horse-power per lb. of crude petroleum, from which not even the solids have been separated. The commercial value of 1 lb. of crude petroleum is less than half the value of 1 lb. of pure hydrocarbon oil, so that, if both claims are equally reliable, the Hornsby-Akroyd engine is a more economical working engine than the Diesel oil engine. It is claimed that the Diesel oil engine is noiseless, because no explosion is said to take place, but this is an error. The noise in the case of gas engines and cannons is not produced by the explosion within the cylinder, but by the impact of the exhaust gases against the air. The pressure in the case of the Diesel oil engine on the eve of exhaust is, according to the diagram, from 10 lb. to 20 lb. more than the usual exhaust pressure, so that, if extra precautions are not taken to smother the noise produced by the impact on the external air, the Diesel oil engine will be more noisy than existing gas and oil engines. There is another cause of noise in machinery, that due to the motion of the working parts. In point of simplicity of construction the Hornsby-Akroyd is much superior to the Diesel engine, and will, therefore, in this respect be less noisy. It seems to me that we cannot give a correct description to the Diesel oil engine without adding a monosyllabic prefix to the word "Rational."

December 2nd. ONLOOKER.

THE PATENT-OFFICE LIBRARY.

SIR,—On the 29th July last, page 105, you published an article on the Patent-office Library, and in your issue of last week there is also an article on the same subject, criticising with some severity the arrangements which you seem to have approved of only four months ago. The impression which a person unacquainted with the Library would form from your latest utterance must be most unfavourable. He would be led to believe that the Library is very imperfect, and that is the impression you evidently wish to convey by the closing words of your article last week, whilst four months ago you spoke of it as "a fine collection." You also call attention "to the importance of a good catalogue," thereby implying that the present catalogue is not good.

I am afraid that I shall be looked upon as a partial witness, having had a good deal to do with the Library. I was responsible for recommending the purchase of some thousands of volumes, and many a battle I have fought with the experts of the Stationery-office, who thought they understood the requirements of the public and the scope and objects of the Library better than I did. You compare it unfavourably with the British Museum, which, ever since its foundation, has been in a position to claim a copy of every English book published. But even in this department the Patent-office Library has no reason to be ashamed of its collection of technical, industrial, and scientific literature, especially as regards the Transactions of societies. The British Museum, however, has no rights over American and continental publishers, and, as regards foreign books, I have no hesitation whatever in claiming on behalf of the institution with which I was so long connected a marked superiority over the British Museum, and over every other library in England. When the Royal Society's "Catalogue of Scientific Papers" was being compiled, the editor and his staff spent many weeks at the Patent-office Library, working upon books which were not to be found elsewhere in London. I remember many instances in which persons have been referred to the Patent-office Library by the officials at the British Museum, and on one occasion this was done in my hearing.

Your suggestion that a book should not be placed permanently upon the shelves until it had undergone a period of probation, when its merits should be weighed by a body of experts, stamps you as a barbarian in literary matters. If adopted the Library would be in a state of constant flux, and you would be amongst the first to complain. What would you say, if you found that a book which you had consulted, say ten years ago, and wished to look at again, had been removed by order of the experts? Nothing is sacred to persons of that class, and they would even lay profane hands on the early volumes of THE ENGINEER, to make room for something more "up to date." It just occurs to me that several volumes of the British Museum set of your journal want the indexes, and are therefore partly useless. The "ideal library," to use your phrase, must contain not only books of the present day, but also those of the past, in order that a true view of the history of a subject may be arrived at. These are days of retrospection, as is proved by the purely historical articles which are constantly appearing in your columns. I was very much struck by an observation made to me many years ago by a well-known publisher and bookseller now dead. Speaking of the Patent-office Library he said, "It is your business to collect costly books, which few can afford to buy, and so-called 'rubbish' which few can afford to keep. The rest will take care of itself."

I have very little knowledge of the Dewey system of classification, but it appears to have one merit, for it can be worked out to any number of places of decimals. But after all it seems to me, as a practical librarian, that it matters little what system of classification be adopted, so long as a book can be readily found. The Patent-office Library is, as you know, housed in temporary premises, but when it is re-established in its permanent home I suppose that a copy of the catalogue of authors and subjects bearing the "press-mark" of each book will be provided for the use of readers. I do not see why a person who only wishes to consult a particular book or books, or to make a search on some restricted subject, should be called upon to master a complicated system of classification. The merits of Dewey's method did not seem to be so apparent to you on the 29th of July as they are now. I hope that some of your readers who have actual practical experience of the present arrangements will come forward and state their views on the matter. But, however elaborate the catalogue may be, and however minute the classification, the "living voice" of the intelligent librarian whose heart is in his work will still be useful as a guide, and this, I believe, will be found at the Patent-office.

75, Dartmouth Park-road, N.W., RICHARD B. PROSSER.
November 30th.

[We are sorry that Mr. Prosser should have so entirely mistaken the meaning of our article on the Patent-office Library. That article was intended to advocate the construction of a *complete* scientific library round the existing collection as a nucleus. There are at present limitations to the scope of the Patent-office Library which we wish to see removed. We do not question for a moment its usefulness, as far as it goes; but even Mr. Prosser, to whom very much of its present position is due, cannot claim that it covers completely all branches of science. It is the library of the inventor, not of the scientist. With regard to the catalogue, we wrote with the first volume of the latest edition before us. We have no hesitation in saying that it does not give the slightest direct indication of where a book is to be found on the shelves. Most large libraries have now-a-days card slip catalogues arranged on some system. If there is such a thing at the Patent-office, it is certainly not placed in a prominent position, and we imagine but few readers know of its existence. How Mr. Prosser has managed to construe a few words of praise of the British Museum into an unfavourable comparison between it and the Patent-office Library, we are at a loss to understand, and also we fail to see what grounds Mr. Prosser has for supposing that we advocate the removal of books that have once appeared on the shelves. Books under consideration might be put on special shelves. Our article of the 29th July was descriptive of the temporary premises, was in no sense critical, and was written before the new catalogue appeared. Read by an unbiassed person, we think no contradiction between the two articles in question will be found.—ED. E.]

SIR,—I have read your article on the Patent-office Library with much interest. Permit me to supplement your excellent comments with a few remarks and criticisms.

The Patent-office Library occupies a peculiar position. It is very largely a national institution, intended to subserve a special purpose. That purpose is to assist those who invent and take out patents. It is the easiest thing in the world to forget this. If it is kept properly in mind, it will be understood that the Library is not to be judged by ordinary rules. What might be very meritorious in a free library, for example, might be quite wrong here. What might answer admirably, or even be of vital necessity in the British Museum Library, or that of the Guildhall, may be quite out of place in the Patent-office Library. This last must be judged on different grounds. Take, for example, the British Museum system, by which a list has to be handed to the librarian, and the reader has to wait, sometimes for a long period, before he gets his books. That system would be quite out of place in the Patent-office Library, in which the reader ought to be able to help himself to what he wants with little or no aid from a librarian. The Patent-office Library is used by busy men for reference, far more than for reading, and everything should be done to reduce the labour and time spent in referring. It is not easy, with a due regard to your space, to make what I mean quite clear to those who do not use the Library for professional purposes. Those who do will recognise at once the force of what I say.

My memory easily carries me back thirty-five years to the time of the Great Exhibition of 1862. The whole of the books, specifications, and so on, of the Patent-office were then stowed away in the dismal corridors of the ground floor in Southampton-buildings. It was an old joke that access was obtained to the Patent-office from Quality-court through a passage, on one side of which was the office of the Commissioner in Bankruptcy, facing which was the office of the Commissioner in Lunacy. The intelligent foreigner regarded the Library with laughter and contempt. Then came the library nearly at the top of the house, and as years went on the indefatigable labours of Mr. Richard Prosser, assisted by the late Mr. Allison, worked wonders. Mr. Prosser had a terribly uphill battle to fight. Red tape bound the Patent-office. A do-nothing policy governed every one. But in the end Mr. Prosser triumphed, and the Library became worthy of the name. But up to the time when Mr. Prosser retired and Mr. Allison died, there was no adequate catalogue, and I think one reason was that Mr. Allison was a catalogue in himself. Everyone who wanted to consult books on any subject went to him. His courtesy was boundless, and knowledge of what was in the Library comprehensive and yet detailed. Mr. Prosser no longer guides; Mr. Allison no longer helps. Two special, peculiar, and invaluable features of the Patent-office Library are withdrawn. In their stead we must have ordinary methods of working. The patent-office must be run on orthodox lines, with librarians and clerks and a catalogue. The question to be decided then is reduced to this: Is the catalogue the best possible; is the arrangement on the shelves the best possible, for what is above and beyond all others a national reference library? I in common with many others who use the Library do not regard either the catalogue or the arrangements as the best. But I live in hope. I know that the existing premises are temporary. It is no disparagement to those who now control it if I suggest that when the new premises are ready and the transfer takes place, Mr. Prosser should be asked to give his assistance in completing the work which he began.

In saying that I am not satisfied that the Library is now all that it might be, it is probable that I shall lay myself open to censure. I regret this, but I cannot help it. A somewhat extensive knowledge of librarians convinces me, firstly, that every librarian has a system of his own; secondly, that his system is the best possible; thirdly, that the arrangement of his own library cannot possibly

be bettered until he gets more money; lastly, that no library ever has money enough spent upon it. I do not suppose that Mr. Hulme, the Patent-office librarian, is an exception to the general rule, and it is not likely that he will be satisfied with what I have written. I do not mean, however, to imply for a moment that he has not done his best, and I do not suppose that he holds that he is above criticism. I admit, however, that it seems scarcely fair to find fault and not particularise. But my excuse is that I could not possibly bring myself to make the demand on your space that a thorough overhauling of all the arrangements would need. I must rest content with the assertion that the Patent-office Library cannot be considered perfect while there remains to be done anything which can facilitate the labours of lawyers, engineers, chemists, patent agents, or indeed of anyone of that great army continually engaged in developing our national industries.

The Temple, December 3rd. THOMAS PINCH.

CEMENT SPECIFICATIONS FOR MARINE WORK.

SIR,—The usual specification for cement for this class of work insists upon a high tensile strain test, and also a high specific gravity. Four hundred pounds per square inch for a briquette made of neat cement at seven days, and a specific gravity of 3·15, are by no means uncommon stipulations.

A high tensile strain result can be obtained, to a certain extent, by hard burning and fine grinding; the hard burning also tends towards a high specific gravity, though the fine grinding is against it. A high percentage of lime, however, means high tensile strain results and high specific gravity, and is the means generally employed by manufacturers to obtain these results, and so make their cement conform to the engineer's specification.

As a precaution against too great a percentage of lime being employed, the engineer knocks up some thin cakes of cement, places them in water, and examines them from time to time, to see whether the cement shows signs of blowing; he is generally satisfied should such signs not be very pronounced. This test, to my mind, is very rough and ready, as a very heavy percentage of lime requires to be present before the cement cakes show marked signs of blowing. The fact of the test briquettes withstanding a tensile strain of 400 lb. or more, and having a specific gravity of 3·15, is sufficient in itself to prove that the cement contains a considerably greater percentage of lime than the silica and alumina can combine with.

The object of having an excess of lime beyond what is required for combination with the other ingredients is, I imagine, to make sure that each particle of silica, or alumina, shall have a particle of lime adjacent to combine with, when the proper time comes. Very intimate mixing of the ingredients will effect this to a certain extent; but there is always the probability, if only just sufficient lime is used, that part of the silica and alumina may escape contact with the lime. To avoid this an excess of lime is employed. This excess of lime, if not too great, may be of advantage in a cement which is to be employed in work hardening in the atmosphere, or in fresh water, but when the work or concrete is to be placed in sea water whilst in an unset condition, this excess of lime is highly injurious, delaying if not entirely preventing the hardening of the matrix.

It is important to remember that in the hardening of the faces of blocks and other concrete work exposed to the atmosphere, the element of the carbonic acid present plays an important part; a small excess of lime may here be an advantage, whereas the hardening of concrete below water containing no carbonic acid is quite a separate chemical process. What actually goes on in the process of the setting of concrete immersed in sea water, and the chemical changes that take place, have been fully investigated and described by Dr. W. Michaëlis, and it is to the discoveries of this eminent chemist that I wish to draw the attention of English engineers.

Dr. W. Michaëlis has devoted many years to the study of this subject, and written papers from time to time setting forth the results of his researches and experiments; yet, judging from the general character of the specifications for cement for sea work, very little notice has been taken of his work by engineers. Herr Nadory Nádor, a Hungarian engineer, has quite recently been drawing the attention of his continental brothers to the importance of Dr. Michaëlis' discoveries; so it would appear that it is not only in England that these discoveries have been somewhat neglected. Dr. Michaëlis discovered, and conclusively proved, by exhaustive experiments, carried on over a period of many years, that the disintegration of concrete placed in sea water whilst in an unset or plastic state was due chiefly to the presence of free lime; that the combination of the sulphates in the sea water and free lime in the cement not only set in motion agencies antagonistic to the hardening of the concrete, but opened up the way for the sea water, and naturally the injurious salts contained therein, to gain access to and abstract the lime already in combination with the silica and alumina in the cement, so in the process of time disintegrating the whole mass. He explains that the agencies at work may be classed under two headings, *i.e.*, (1) those that tend to the hydraulic hardening, or, as I will put it, consolidation of the mass; (2) those which tend to crystallisation, or expansion of the mass. Free lime in the cement, and the sulphates in the sea water, come under the latter heading, and as the expansion increases they are gradually admitted to the heart of the work, which, if it has not become sufficiently consolidated to resist their attack, is finally dissolved and crumbles away.

Of course the chemical action that goes on in concrete immersed in sea water is very slow, and we do not expect to see the work go to pieces in a few months, or even years, after it has been placed *in situ*. But the action is going on nevertheless, and should the crystallisation forces predominate, which, with a large excess of lime in the cement, they are bound to do, the failure and destruction of the mass is only a matter of time.

I have examined a good deal of concrete in sea work, concrete only exposed at ebb of spring tides, and which was built *in situ*. My experience is that in most cases the matrix is not hard, but of a fairly tough putty-like consistency easily scraped away with the point of a penknife. I think that Dr. Michaëlis' experiments go to prove that this cement mortar will never harden, but on the contrary, little by little lose its toughness, and eventually become little better than mud.

In conclusion, I would invite those interested in this subject to read, if they have not already done so, Dr. Michaëlis' contributions to the Minutes of "Proceedings" of the Institution of Civil Engineers; also extracts from other publications—they can then judge for themselves whether I am right, or not, in suggesting that specifications for cement for sea work should take a very different form, or if this is not to be, that engineers should adopt the alternatives advocated by Dr. Michaëlis. JOHN L. WATSON.

Allen-street, Kensington,
November 28th.

SIR,—Mr. de Michele's statement about testing cement with sand is reasonable considering the different kinds of sand that exist. In his cement specification which he gives in THE ENGINEER of the 2nd inst., there are tensile strengths given for seven and fourteen days, showing an increase of 50 lb. on the square inch for the extra seven days. Would it not be preferable to specify a percentage of increase, as many cements give over 400 lb. per square inch for seven days, and even occasionally are over 450 lb?

Three briquettes appear to be scarcely sufficient, as even the most skilled tester at times has accidents in making experiments as to the strength of the cement under observation. The quicker the strain is applied the higher the result, and in most machines the greater jerk the weight gives on the bar, often giving a result 10 lb. higher than the truth. This seems to point to moderation of application of strain. The specification contains nothing about the specific gravity or even the weight per bushel of cement. Does Mr. de Michele claim that this is not necessary in a specification? It is high time that the constituents of concrete other than cement received more attention in drawing up specifications of important works than they often do, as the cleanliness, sharpness, size, and character of the ballast used affect the ultimate result quite as much as the quality of the cement does.

Bushey Heath, Herts., ALFRED E. HURSE.
December 5th.

SAFETY MOUNTINGS FOR EMERY WHEELS.

SIR,—I have naturally perused with great interest the correspondence you have been recently publishing on this subject. If it be true that there is nothing new under the sun, inventors are certainly the last people in the world to recognise it, and of re-inventions there is no end.

Your readers have been taken back to earlier and earlier periods, and I now beg to refer them to the Patent No. 3193 of November 11th, 1867, in the names of Frederick Ransome, Henry Bessemer, and Ernest L. Ransome, in the drawings attached to which may be seen the identical arrangement illustrated by Mr. Sterne. I have a copy here, but anyone can satisfy himself by a visit to the Patent-office.

One of my earliest experiences with this shape of emery wheel—viz., a thickened centre and a correspondingly-shaped side plate, which naturally permits of a very large hole—was in 1870, in which year I first became connected with Ransome's Patent Stone Company, of which Sir Henry Bessemer was chairman, and I well remember such shaped wheels being made for a large Liverpool firm. Later on, when a patent was taken out for a practically identical article, I wrote in a friendly way to call attention to this, and saying I should, of course, continue to use this shape whenever I thought fit, and I have, in common with other makers, constantly done so.

The idea is undoubtely good, and probably the only reason why it has not been more generally adopted is simply that there is practically no call from consumers for this or any other "safety device," because there is substantially no danger in the use of emery wheels running at the usual surface speed of about a mile a minute, and mounted in the common manner between two iron side plates; of course, if used with ordinary discretion.

If it be argued that accidents do happen, the reply is obvious:—"In what department of life do they not occur?" Statistics incontrovertibly prove that an actual workman is infinitely more likely to be damaged by a falling chimney pot, a restive horse, or even crossing an ordinary street, than by a bursting emery wheel; and the very fact of the attention that is excited by the very few occasions of personal injury is an added proof of their rareness. Natural grindstones come to grief infinitely more frequently than artificially-made emery wheels, notwithstanding that the makers of the latter are many and the experience of some of them is of a very superficial character. In my own twenty-eight years' experience of the particular trade, I am thankful to say the number of accidents of which I have become aware has been exceedingly small, and in almost every case has been clearly traceable to such a shocking disregard of the most elementary rules of mechanics and common sense as absolutely invited disaster. Most of the older makers could fill many of your columns with a recital of the startling experiences they have passed through in this direction.

While unwilling to obtrude too much personal remark, may I be excused for saying that with all the running, both for trueing and testing of certainly over 100,000 wheels, during the above-mentioned period, not a workman has been incapacitated by accident for an entire day, notwithstanding the inevitable contempt bred of familiarity.

Let us by all means guard against all kinds of danger to the utmost of our power, both on the moral ground of acting towards others as, under similar circumstances, we should wish them to act towards us, and on the more modern condition of the exigencies of Employers' Liability Acts; but let us also avoid talking too much of "safety devices," and thereby permit by implication an exaggerated idea of danger to creep into the minds of those who have not carefully studied an interesting and useful subject.

Westcombe-hill, Greenwich, S.E., A. H. BATEMAN.
December 3rd.

SNAKES AND SAFETY VALVES.

SIR,—The motto, "Truth is Stranger than Fiction," appears on the cover of one of your contemporaries, and the editor certainly does his best to live up to it. As the avowed object of the magazine in question is "to publish true stories of actual experience, avoiding fiction," perhaps you can find space in your columns for some remarks on one of the true stories which concerns engineers.

I happened to notice in the current number an illustration of a snake coiled round a safety valve, which is apparently discharging steam in considerable volume, and being somewhat curious to learn whether the snake did not find its position rather warm, I read the article through, with amusement if not profit.

We are informed that the engineer in charge of the boiler lights his fires, but that "scarcely had the water begun to bubble" when he is called away, leaving the boiler in charge of the hero, a lad "who had been about machine shops ever since his infancy, and therefore knew as much about engines as do many certificated engineers." The next few paragraphs go to show that the complaint sometimes made about the Lancashire boiler being a slow steam raiser is quite unfounded, for we learn that "in the few minutes that had elapsed since the engineer's departure" the steam was up to 110 lb. The "astounding photographs"—*vide* cover—show that the boiler is of the Lancashire type, none of your new-fangled "express" boilers.

The hero who knows so much about engines, on finding the pressure somewhat high, makes a "frantic dive" for the boiler-house door "intent upon saving his life," and when he cannot get out his only idea of reducing the pressure is to get up on top of the boiler and hold the safety valve open, this being, we are told, "his one chance." This evidently would require considerable courage, as the boiler is "roaring" and "making frantic lunges in his direction."

However, he is baulked in his intention, for there happens to be an enormous rattlesnake round the "supply pipe." One would suppose that the writer means this for the feed-pipe, were it not for the first-mentioned "astounding photograph," which shows the snake round the safety valve, and also for the fact that it does not seem clear why the hero did not get up somewhere else if the snake were on the feed-pipe. Further, this pipe gets "intensely hot" as the drama proceeds, so perhaps the photograph is right, but no explanation is forthcoming as to whether snakes like coiling round bare safety valves at a temperature of nearly 350 deg.

I need not take up your readers' time with the battle of the snakes, and will conclude by informing them that finally the hero, "with one mighty blow, *knocks off the safety valve*," and is saved.

December 3rd. RICHARD MCLAREN.

HIGH SPEED AIR PUMPS.

SIR,—The remarks of Mr. Dunlop on the Edwards air pump in your issue of the 25th ult. seem to imply that Mr. Edwards claims the entire credit of a valveless bucket and ports in the barrel side. These features, as is well known, are not novel. What Mr. Edwards apparently does claim is the mechanical propulsion of the water into the barrel in such a manner that the shock due to impact is minimised, and in a direction which will assist the free inflow of air. That these are recognised as distinct improvements is shown by the fact that the Edwards pump is being very largely adopted, and having had personal experience of its working, I am of opinion that it marks a distinct advance in steam engineering. The object of "Antiquarian's" interesting sketch in your last issue is, no doubt, not to depreciate Mr. Edwards' invention, but to illustrate the value of research and development.

If two pumps were made in accordance with the two designs, the difference in efficiency would, of course, be very great, as in the Bodmer design the air inlet, for example, is exactly where it should not be. This is, however, yet another instance of how little often stands between failure and success. MARINE.

LIVE STEAM FEED-WATER HEATERS.

SIR,—I believe that I have read all the articles which you have written on this subject since that written after your experience with the Oriole. Indeed, the interest created by reading some of these articles was such that I selected one of the best examples of machinery and boilers which I had, and fitted a Kirkaldy live steam feed-water heater. The example of machinery and boilers was produced by Messrs. Palmer's Shipbuilding and Iron Company, Jarrow-on-Tyne, than whose productions, for economical results, there are few to equal and none better.

Herewith I give you figures, taken from the chief engineer's log, for two voyages immediately before and for two immediately after the feed-heater was fitted. An examination of these figures will show that, in this case, not the slightest reduction of coal consumption was obtained. Nor is this the only example; I have five others. But, nevertheless, a live steam feed-heater is useful, not because it sometimes won't save coal, but because boilers, when their feed is heated, behave themselves better than when it is not heated, and they look more refined when examined inside.

Number of voyages.	Time on whole voyage, days. hrs.	Distance steamed miles.	Steaming time, dy. hr. min.	Average speed, knots per hour.	Daily consumption of coal, tons cwt.	Total consumption of coal, tons.
19	64 5	12,414	50 18 50	10·47	37 0	1,953
20	72 11	13,110	51 11 35	10·93	37 7	2,072
Kirkaldy's Live Steam Feed-water Heater Fitted.						
21	65 19	12,743	51 20 30	10·7	37 12	2,018
22	67 6	12,414	50 4 37	10·47	37 0	1,954

If steam must be used to heat feed-water, why not use Weir's, which is the only theoretically correct and practically perfect system, and about which there is no mystery?

November 29th. ALEXANDER DALRYMPLE.

THE INSTITUTION OF CIVIL ENGINEERS' ENTRANCE EXAMINATION.

SIR,—I think your correspondents have overlooked the only real grievance in connection with the examination for election as associate members—I mean that no certificate is sent to a successful candidate.

It seems only fair that those who have been put to the trouble and expense of sitting for the examination should have something to show for it, more than those who have not had this to do. Of course, present associate members could sit for examination and so gain this certificate.

I hope you will find space to print this letter, and that the Council, while there is yet time, may see their way to put this right. ONE WHO HAS PASSED.

November 30th.

POSITION OF DRAUGHTSMEN.

SIR,—Will you kindly allow me a few lines in your valuable paper to invite any draughtsman who is willing to become a member of a society whose object is for the betterment of their position? I am quite prepared to receive any communications upon the subject, and shall be much pleased if a sufficient number of answers are forthcoming to warrant further steps being taken. All correspondence will be treated confidentially, although my own opinion is that employers as a body will not only encourage but substantially assist such an undertaking, and so venture to dub myself secretary *pro tem.* J. GILLAIRD.

34, St. Mary's-road, London, N.,
November 30th.

ANNUAL DINNER OF THE INSTITUTION OF ELECTRICAL ENGINEERS.

THE tenth annual dinner of the Institution of Electrical Engineers took place on Wednesday evening at the Hotel Cecil, the President, Mr. J. W. Swan, F.R.S., being in the chair. There was a large gathering, numbering some 270, among whom were the Right Hon. the Earl of Dundonald, Lord Monkswell, Lord Greenock, the Right Hon. G. Shaw Lefevre, the Attorney-General, the Earl of Lichfield, General Sir R. Harrison (Inspector-General of Fortifications), Admiral Sir W. J. L. Wharton (Hydrographer of the Admiralty), Mr. W. H. Preece (President of the Institution of Civil Engineers), Sir A. K. Rollit, the Hon. W. P. Reeves (Agent-General for New Zealand), Sir Courtenay Boyle, Sir J. Crichton Browne, Professor Ramsay, Sir Edward Frankland, Dr. Ludwig Mond, &c.

The toast of the evening, that of "The Institution of Electrical Engineers," was proposed by Sir Richard Webster. The Attorney-General referred with emotion, as did several succeeding speakers, to the serious losses which the Institution had suffered during the past year by the deaths of Mr. Latimer Clark and Dr. John Hopkinson, paying a generous tribute to the value of each. Sir Richard then went on to remark that although electricity had been known to exist many years previously, yet it was only during the sixty years of her Majesty's reign that the science had made the great strides which it has done, and he gave a sketch of the progress of telegraphy by land and sea, and traced the history of electrical development through all the advances of succeeding times till the present day, and concluded by proposing the toast coupling with it the name of Mr. Swan, than whom, he said no man was better fitted to hold the post of president. Mr. Swan had frequently, he added, kept him straight in electrical matters in times gone by.

Mr. Swan, in his reply, said that whereas before the Victorian era the attention of electricians had been devoted to preventing electricity from doing mischief, the engineers of the present day were directing their energies towards bringing it into subjection, and making it a useful, obedient, and profitable servant. He alluded to the beginnings of electricity, and to the prominent position it now occupied, and said that throughout the world the number of miles of railway or trams worked by electricity could be counted in thousands, the number of horse-power transformed into electrical energy by hundreds of thousands, the length of telegraph and telephone lines in millions of miles, and the number of glow lamps in tens of millions.

Mr. Swan then proposed the toast of "The Navy, the Army, and the Reserve Forces," saying that though he was all for peace, yet he realised that some wrongs could only be righted by force.

The toast was responded to by Admiral W. Wharton and Sir Richard Harrison who, both testified to the aid which electricity afforded in the defence of the country, and also by Mr. R. E. Crompton, the newly-elected captain of the Corps of Electrical Engineers (R.E.) Volunteers, who deplored the loss of their original captain, Dr. John Hopkinson.

Sir James Crichton Browne proposed "Science," in an eloquent speech, which was replied to by Mr. Preece and Professor Ramsay, and the proceedings terminated after the final toast, "Our Guests," which was proposed by Major-General Webber, and replied to by the Right Hon. G. J. Shaw-Lefevre and the Hon. W. P. Reeves, Agent-General for New Zealand.

PORTABLE HAND-PUNCHING AND SHEARING MACHINES.

THE illustrations, Figs. 1, 2, and 3, given herewith, represent two ingenious portable appliances for shearing and punching joists, angles, tee, and channel iron by manual labour. The construction of both these machines is simple. Their operations, it will be seen, are based upon the same mechanical principles. The section to be sheared is introduced between suitable upper and lower knives in the open space shown, and intense pressure is brought to bear upon it at the desired point by the upper cutter through the medium of the pressure bar c^1, Fig. 2, and the system of levers $g\ m^1\ m^2\ l$, the bar c^1 being excentrically pivoted, as shown. The cutters are supplied of different shapes to suit the section to be operated upon. Those shown shear one-half of the H section at one operation. The upper cutter f^1 is lowered to its work by releasing a spring on the handle f^4; the pressure bar c^1 is brought to bear upon the cutter by releasing the lever c^2, a wedge b being introduced to make a close fit. The lever g is next depressed to an oblique position, similar to that shown in Figs. 1 and 3, so as to bring pressure to bear upon the cutter. On the top of the lever g are two pawls $i\ j$, which gear with the teeth of the ratchet levers $m^1\ m^2$. The serrations on both these levers are of different sizes, the lever having the larger-sized teeth being used to depress the lever

Fig. 1—HAND SHEARING MACHINE

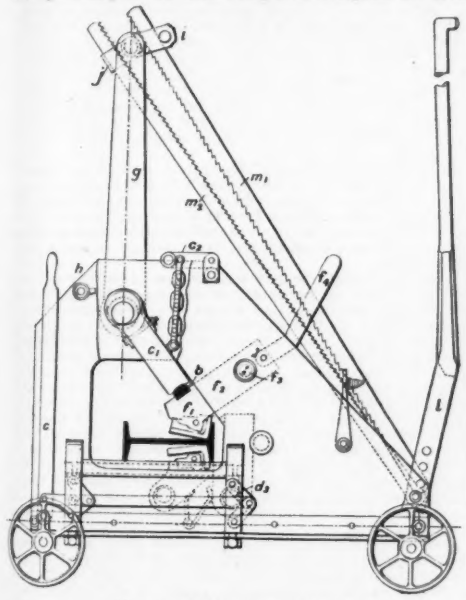

Fig. 2—SHEARING MACHINE

g by means of the hand lever l, while the lever m^2 serves to maintain the pressure on the article under operation, while

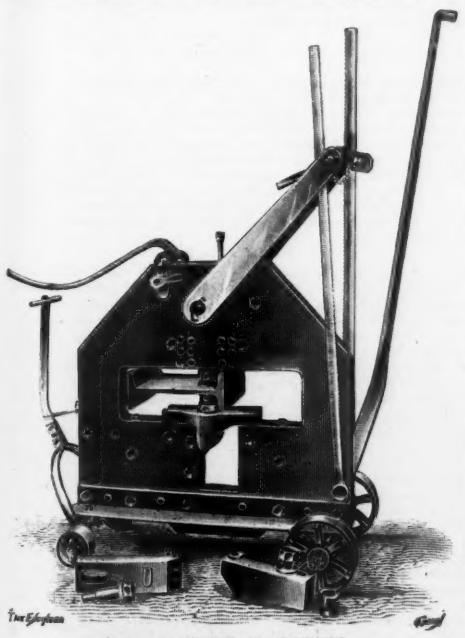

Fig. 3—PUNCHING MACHINE

the hand lever l is brought up again to its vertical position to start a fresh stroke. A roller support, shown in Figs. 1 and 2, is provided for raising and lowering the material to suit the cutters. Although it is claimed that a couple of men in cutting a 12in. joist bring a pressure of 120 tons to bear upon it, the speed of working is not nearly so slow as might reasonably be expected. It will be observed that the leverage obtainable is very great. The engraving of the punching machine shows the dies arranged for making holes in the web of a joist. The essential features of the machine are similar to that above described. There must be many conditions where such appliances as these would be a boon to engineers, contractors, bridge and shipbuilders, and others. The machines, which are substantially made, are being introduced into this country by Messrs. R. Becker and Co., Rivington-street, Curtain-road, London.

INSTRUMENTS FOR MEASURING SMALL TORSIONAL STRAINS.*

By E. G. COKER, B.A., B.Sc., M.I.M.E., Late Scholar of Peterhouse, Cambridge.

THE advances made within recent years in the scientific testing of engineering materials have caused great attention to be paid to the design of instruments for measuring small strains. By far the greater number of such instruments have been devised for measuring the small strains of extension or compression in bars subjected to a direct pull or push, and but little attention has been paid to instruments for the use of engineers, in the measurement of the small strains in a bar subjected to twist.

The object of the present paper is to describe two arrangements of apparatus intended for use in engineering laboratories and testing houses for measuring such strains, and for the determination of the modulus of rigidity.

Each instrument is wholly supported by the test bar, being secured thereto by screws, which grip the bar at two transverse sections separated by a known interval, and the relative angular displacement between these two sections is measured directly. The instruments are adapted to measure both large and small

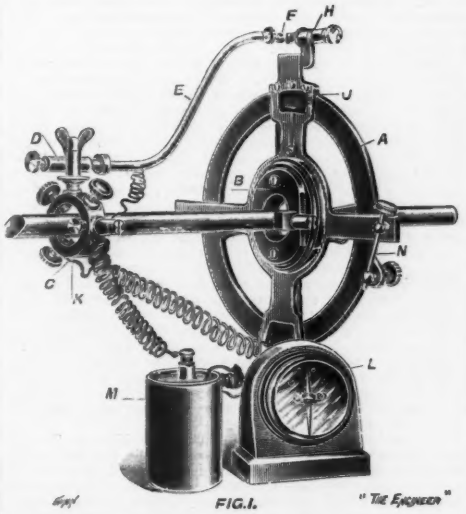

FIG. 1. "THE ENGINEER"

strains, and are self-contained, while they can be used in a horizontal, vertical, or inclined position.

One form of the apparatus is shown by Fig. 1, and consists of a graduated circle A, mounted upon a chuck plate B, provided with three centering screws adjustable by hand. A ring C, secured to the test bar by set screws at a known distance away, carries a swivel arm D, in which slides a tube E, so that the contact ball F at its outer end can be brought into position touching the centre of the faced end of a screw micrometer gauge H provided with a divided head. This micrometer screw is mounted upon a vernier plate J of the graduated circle, and can be clamped in any position, the final adjustment being effected by a screw N.

A silk-covered wire connects an insulated binding screw K upon the ring with the contact ball, and this wire is joined up in circuit with a simple form of galvanometer L and cell M to a second uninsulated binding screw on the ring. If the contacting pieces are touching a circuit is completed through the test bar, and the galvanometer needle is deflected. If now a twisting movement is applied to one end of the test bar the contacting pieces are separated, and the micrometer screw must be advanced until the circuit is again completed as indicated by the galvanometer needle. The number of divisions through which the screw has been turned affords a measure of the angular displacement, and it only remains to calibrate these readings in terms of angular measurement. The calibration is effected by reference to the graduated circle and vernier plate.

The micrometer screw is set tangentially to the radial arm, and therefore its indications are nearly proportional to the tangent of the angle moved through, but if the faced end of the screw is always maintained at or about its central position, the error introduced by taking the readings as directly proportional to the angular displacement is relatively small compared with the quantity under measurement, and may be neglected. To calibrate the instrument it is therefore only necessary to measure the number of divisions corresponding to a small angular displacement of, say, 10^1, and this is easily accomplished by setting the instrument in position with the circuit complete, and afterwards following up a known angular displacement of the vernier plate by the micrometer screw.

A single form of detector galvanometer, in circuit with a single dry cell, has been found to be a convenient arrangement for indicating when contact takes place, and the feeble current required does not injure the contacting surfaces. It is essential that the graduated circle be set accurately upon the bar, with its plane perpendicular thereto, and its centre coinciding with the longitudinal axis of the bar. An arrangement has been devised to effect this, consisting of two similar and equal clamp bars, the eyed ends of which take over outwardly-projecting cones arranged diametrically upon the chuck plate and ring. Each main piece

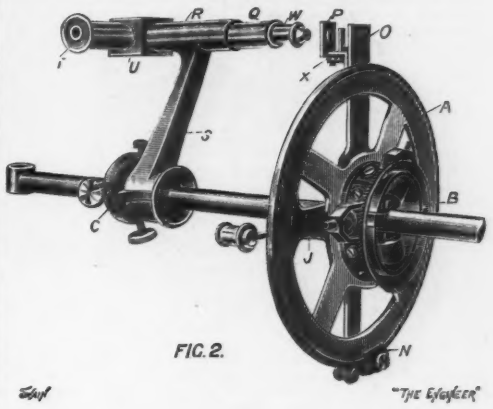

FIG. 2. "THE ENGINEER"

has one degree of freedom with respect to the clamp bars, and therefore two degrees of freedom with respect to the other; these degrees of freedom are suppressed by projecting plates fitting against corresponding projections on the main pieces, and this connection makes the apparatus a rigid whole. The bar is now inserted, and the screws adjusted by hand as accurately as possible. The clamp bars are afterwards removed, leaving the two main pieces accurately spaced on the bar, while the graduated circle remains perpendicular thereto, and very approximately centred. The light contacting arm is then clamped in position, and the bar may now be set in the testing machine. An improved clamp described with reference to the second form of apparatus may be used instead of the arrangement described above, and the hand-operated chuck plate may be replaced by a form of self-centering chuck described below. An example of tests made with this apparatus is given below. The test bar was adjustably secured at one end, and a balanced lever of fixed length secured upon the free end, and hung from the arm of a scale beam. The load was applied by placing equal weights in the suspended pans of the balanced lever and scale beam, so that bending movement was as far as possible eliminated. Before making a reading, the torsion arm was brought to a horizontal position by aid of a spirit level. The mean of the calibration tests gave 18·6 divisions of the micrometer screw as corresponding to an angular displacement of one minute of arc. Turned bar of Bessemer steel, length under measurement = 10·25in., diameter = 0·747in., torsion arm = 15in., a constant.

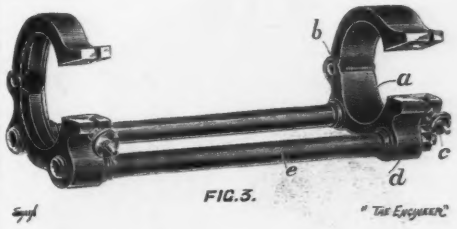

FIG. 3. "THE ENGINEER"

The figures in the first column give the load in the pan at the end of a constant arm :—

Load, pounds.	Reading.	Difference.
0	0	26
1	26	25
2	51	26
3	77	26
4	103	25
5	128	26
6	154	25
7	179	26
8	205	26
9	231	25
10	256	27
11	283	24
12	307	26
13	333	25
14	358	26
15	384	26
16	410	25
17	435	25
18	460	25
19	485	25
20	510	

If l = length of the bar,
d = diameter,
$T\ m$ = twisting moment,
θ = relative angular displacement,
C = modulus of rigidity,

Then for bars of uniform circular section

$$C = \frac{32\ T\ m\ l}{\pi\ d^4\ \theta}$$

and we have for this test bar

$C = 11{,}790{,}000$ lb. per square inch.

A second test gave almost identically the same results.

The performance of the instrument is limited by the accuracy of the micrometer screw, and in the present instrument the smallest

* British Association, Section G.

angular displacement capable of measurement is about four seconds of arc. As the contacting bar is not heavy, no difficulty is experienced in balancing it, and therefore its length may be considerable. This form of instrument is therefore adapted for measuring the strains in long test bars.

The second form of apparatus differs from the preceding in employing a reading microscope to observe the relative angular displacement of a radial line upon the vernier plate. The edge of a thick wire is a very convenient line for observation, and has been used with notable success in an extensometer designed by Prof. Ewing—"Proc." Roy. Soc., May, 1895. The instrument is shown by Fig. 2, in which A is the graduated circle mounted upon a chuck B, and furnished with a vernier plate J, an arm O of which carries a wire P. A reading microscope is carried in the sleeve R of an arm S mounted upon the short cylinder C, which latter is gripped upon the test bar by screws. The reading microscope has an eye-piece T provided with a glass scale, and a right-angled prism U is interposed between this and the objective W, so that readings can be easily taken. The tube Q is free to slide or rotate in its guide R, but in order to readily focus the wire this latter is carried in a frame X, pivoted upon the vernier plate J, and adjusted by a screw.

The microscope arm S is secured to the cylinder C by a divided

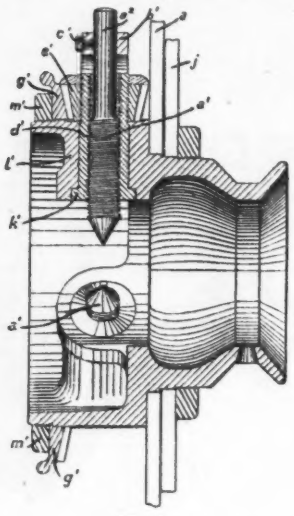

Fig. 4

collar, the two halves of which are pivoted on one side and the free ends are clamped by screws. If it is desirable that the telescope be turned round or released altogether the screw may be thrown out of engagement. Since the difference between an arc and its corresponding chord is an infinitely small quantity of the third order, when the arc is an infinitely small quantity of the first, the readings of the microscope scale may be taken as directly proportional to the angular displacement, and the calibration is effected by moving the wire through a definite angle of 10', and noting the equivalent reading of the micrometer eye-piece.

This instrument is furnished with an improved form of clamp—Fig. 3—consisting of a pair of divided collars *a*, the halves being pivoted together at *b*, and secured by nuts *c*. The collars are wedge-shaped in radial section to engage with corresponding wide-angled grooves upon the chuck plate and cylinder, only the angled sides being in contact, so that the collars are readily fixed when required. The lower halves *d* of the divided collars are connected by one or more distance pieces *e*, so that when the former grip their respective grooves each piece has one degree of freedom with respect to the clamp, and this can be suppressed by a pin or by the frictional grip of the collars, thereby causing the parts to act as one rigid whole for setting the instrument on the bar. The

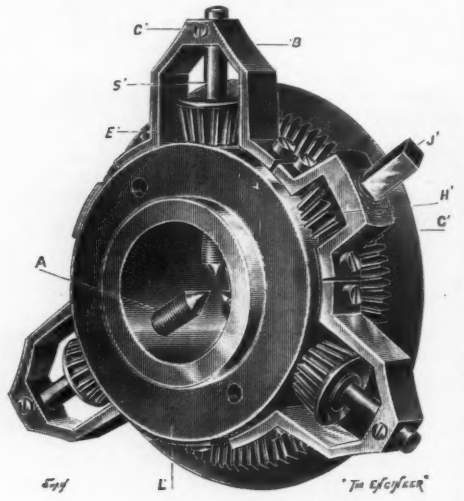

FIG 5.

graduated circle of this instrument is carried by a self-centering chuck of somewhat novel form, and a section through this is shown by Fig. 4, while a perspective view of the arrangement is shown by Fig. 5.

There are three centering screws A^1, the outer cylindrical ends of which are supported in guides B^1, and prevented from rotating by pins C^1 engaging with slots S^1, cut in the screws. The screws work in rotating nuts D^1, provided with bevel pinions E^1, gearing with a hand-operated bevel ring G^1, so that all the screws are advanced or receded together. An additional pinion H^1 is provided, operated by a key fitting on its squared spindle J^1, so that the screws are firmly gripped upon the bar. The inner ends of the nuts have a collar bearing K^1, so that the stresses are borne by the body L^1 of the chuck, and the bevel ring is prevented from seizing by bearing-plates and an adjustable ring M^1 at the back. This bevel ring can be slid back to allow any screw to be separately adjusted. Other modified arrangements of the chuck have been tried, in which the guide pins have passed bodily through slots cut through the inner ends of the screw, and the screw pairs have been inverted, but these modifications have not answered well.

An example of tests made with this form of apparatus is appended, the same Bessemer steel bar being used:—Mean value of calibration test, one minute of arc corresponds to thirty-six divisions of scale. Length under measurement, 8in.; diameter, 0·747in.; torsion arm, 15in., a constant:—

Load, pounds.	Reading.	Differences.
0	800	
1	759	41
2	718	41
3	677	41
4	636	41
5	596	40
6	555	41
7	513	42
8	471	42
9	430	41
10	389	41
11	349	40
12	309	40
13	267	42
14	225	42
15	288	42
16	143	40
17	103	40
18	62	41

And we have for this test bar C = 11,850,000 lb. per square inch.

A second test gave very approximately the same result. Angular displacements of 1in. can be measured with this form of apparatus. As the overhanging arm carrying the microscope is necessarily heavy, to afford the requisite stiffness, the length under measurement is limited. For the purpose of making the angular displacements visible to an audience, a magnifying arrangement is used, consisting of a tilting mirror, supported upon a tripod. Two legs of the tripod are supported by a hole and slot carried upon the vernier plate, and the third leg is supported upon a plane attached to the other main piece. The spot of light reflected from the mirror is caused to move over a fixed graduated scale, and the angular displacement is thereby made visible.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

Economy of heavy goods engines.—The economy in transportation due to hauling as heavy train loads as practicable is leading many railways to put on goods engines capable of hauling heavier trains than those taken by the older engines. On the Burlington and Missouri River Railroad, 90-ton locomotives, which haul 600 tons, are replacing older engines which haul only 350 tons. The engines are all of the Consolidation type, having eight coupled driving wheels and a two-wheeled leading truck. They run on a division 107 miles long, with grades of 2 and 3 per cent. and curves of 360ft. and 573ft. radius. All the wheels are flanged, though usually blind tires are used on one or two pairs of drivers on such engines, but the wheels are set ½in. closer together and have slightly smaller flanges on the front and rear drivers. The engines have immense boilers, with Belpaire fire-boxes, and are so high that the safety valves are mounted on a separate fitting instead of on the dome. Sand is fed by an air jet. The leading dimensions are as follows:—

Cylinders	22in. by 28in.
Driving wheels	4ft. 4in.
Truck wheels	2ft. 6in.
Driving wheel base	15ft.
Total wheel base	23ft. 6in.
Weight on drivers	166,000 lb.
,, total	181,200 lb.
Boiler, diameter	6ft. 2in.
,, rail to centre line	8ft. 9½in.
,, pressure	180 lb.
Fire-box, length	9ft. 5½in.
,, width	3ft. 4in. to 5ft.
,, depth	5ft. 8½in. to 5ft. 11½in.
Tubes, 292; diameter	2¼in.
,, length	14ft. 6¼in.
Heating surface, tubes	2486½ square feet
,, fire-box	188½ square feet
,, total	2675 square feet
Grate area	31⅞ square feet
Smokestack, 8ft. high; diameter	1ft. 5in.
,, height from rail	15ft.
Tender—	
Wheels	3ft. 1in.
Weight, empty	35,000 lb.
,, loaded	94,200 lb.
Length over frame	32ft. 3½in.
,, of tank	19ft.
Width of tank	9ft. 6in.
Capacity of tank	5000 gallons
,, coal space	17,500 lb.

Naval engineers.—Now that the war with Spain is over, it is hoped that steps will be taken for the final settlement of the "line and staff" controversy among the officers of the navy. The engineers receive a much higher degree of technical education in this country than in England, and the proposed plan of settlement is to amalgamate the two grades. It is sometimes urged that the executive power of engineer officers should be confined to the engine and boiler rooms, but this is not practicable, as in a modern warship the engineering department covers a great number and variety of auxiliary engines and mechanical appliances, which require engineers to manage them and keep them in order. If the engineer officers were in charge merely of the main propelling engines, these various auxiliary engines and appliances would be entrusted to line officers, who could not safely be given such charge unless properly trained as engineers. As a matter of fact, the junior officers of all grades are now necessarily giving a considerable amount of technical and engineering work, and the training of the two classes of officers is the same for a great part of the course. Line officers are already in charge of much electrical and mechanical plant, many of them have invented valuable apparatus and mechanism for the guns, range finders, &c., and some who have resigned from the service have attained prominent positions in the engineering field. The controversy is the outcome of an entire and radical change in the methods of conducting naval warfare, and the operations of a warship depend vitally upon engines, machinery, and engineers. The engineer is not an auxiliary officer, as in the days of sailing ships with auxiliary power, but he is as important as the captain and the lieutenants. The proposed solution, which is in every way logical and desirable, is to make all officers line engineers.

Three-stage air compressor.—The Boston and Martana Consolidated Copper and Silver Mining Company has installed at its West Colusa mine shaft a three-stage air compressor driven by a triple-expansion engine of the Corliss type. The compressor and engine were built by the Nordberg Company, which favours multiple-stage compression, and has adapted its design of Corliss engine to plant of this kind. The engine is of the triple-crank tandem horizontal pattern, with two fly-wheels, one on each side of the centre crank. The steam cylinders are at the rear end of the bed-plate, with the air cylinders placed tandem to them, the piston-rods of the latter cylinders carrying the connecting-rods. The steam cylinders are 15in., 18in., and 42in. diameter, by 42in. stroke, all having steam jackets and being fitted with the Nordberg-Corliss valve gear. The cranks are set at 120 degrees, and the intermediate crank is provided with an adjustable alignment box to compensate for any difference in the alignment of the shafts. The cut-off on the high-pressure cylinder is controlled by a static regulator, with pressure cylinder. The cut-offs on the intermediate and low-pressure cylinders are regulated by hand, and the operations can be accomplished while the engine is in motion. The air cylinders are 19in., 27in., and 39in. diameter, with a stroke of 42in. They are bolted to the frames, and have water jackets for cylinders and heads, these parts being separate castings. The air valves are of the Corliss type, and are fitted in the heads. The intercoolers are of the tubular type, set above and between the air cylinders. The cooling surface is so proportioned that air will leave each intercooler at a temperature only two or three degrees above that of the water. The mean effective pressure of the compressor is about 27 lb. per square inch. The receiver pressure is 90 lb. This machine runs fifty drills.

THE INSTITUTION OF CIVIL ENGINEERS.

THE EFFECT OF SUBSIDENCE DUE TO COAL WORKINGS.

At the ordinary meeting on Tuesday, November 29th, Mr. James Mansergh, vice-president, in the chair, the paper read was on "The Effect of Subsidence due to Coal Workings upon Bridges and other Structures," by Mr. S. R. Kay, Assoc. M. Inst. C.E.

The subject of the paper had frequent application in the busy industrial districts of the coal fields, where lofty buildings, heavy bridges, and costly tunnels were often found in the immediate neighbourhood of colliery operations. It was necessary, therefore, in designing works in such districts to know, first, the principles of subsidence following the working of coal, to determine the position and character of the works; secondly, an approximation to the area necessary to be left unworked for the protection of the same; and, thirdly, how the design may be suited to the supposition that the coal may afterwards be worked without any solid pillar being left for support.

Subsidence always followed coal working where no pillars were left, and was generally proportionate to the thickness of material excavated. The depth regulated roughly the duration of the movement. Subsidence might be modified by tight packing of the goaf, where no coal was left for support, under the area to be protected.

Faults were responsible for much of the damage resulting from coal working. Their lines were those of greatest weakness in the strata overlying the coal, and subsidence would sometimes travel many yards out of its ordinary course along such lines. They were, therefore, to be avoided in the erection of permanent works, even if pillars of coal were purchased for support, as it was impossible to guarantee against a possible "drag" or "pull over" of the strata, unless an abnormally large area of support was secured, and this on economic grounds was inadvisable. In the absence of faults, natural breaks and joints in the strata, within the limits of the dynamic effect of the subsidence, formed the lines of weakness. Fractures seldom found their way to the surface from depths greater than 100 yards, unless the thickness of the seam was considerable, or a thick bed of rock intervened. Workings had been safely carried under canals and rivers at that depth. Subsidence was slower in deep than in shallow mines, and surface breaks were rare save along lines of fault. The effect was felt in the case of buildings more in the nature of a "pull over" than of an actual break. The strain moved with the working face, and was not brought into play unless the working ceased for a sufficient time to cause it to become operative.

A series of levels, extending over five years, had been taken by the author over two separate colliery royalties under which the coal was being worked, at depths of 120 yards and 330 yards respectively. They proved, in the former case, that subsidence closely followed the extraction of the coal, and continued for 3½ years, amounting to 70 per cent. of the thickness excavated; in the latter case it followed somewhat later, continued for four years, and amounted to 64 per cent. of the thickness excavated. The strata in each case were fairly level and of the average coal-measure character; the movement was uniform, without breaking the surface.

Subsidence around pillars left for support was shown to be most irregular in its action, and no theoretical formulas could be enunciated to apply to all cases, giving the size and position of the support necessary. All rules for that object were therefore of an empirical character, and subject to modification by local considerations. If absolute immunity was to be secured, an ample pillar should be left.

If the site of works be over a fairly large area of goaf, even settlement might be expected, and when complete the surface would be left nearly as before, though at a lower level. Works should be placed away from goaf edges if possible. A period of two years or three years at least, after the coal was extracted, should elapse before commencing works, and more, if possible, in the case of deep mines. In building ordinary road or railway bridges, or viaducts, the form of the arch should be avoided and steel superstructure employed, having the requisite elasticity to adapt itself to any slight movement subsequent to erection. Waterworks and reservoirs, where certain heights above sea level were to be maintained, should not be constructed in mining districts unless the suitability of the site outweighed the cost of protection. Where coal was worked underneath canals the banks must be puddled and raised to the extent of about two-thirds of the thickness of the excavation. Locks should, as a rule, be protected by pillars.

In horizontal mines the theoretical line of break or subsidence over the edge of a pillar was vertical, or nearly so. In practice this was found to vary to one side or the other, owing to the natural lines of weakness in the strata leading the breaks out of the theoretical course. This must be allowed for in setting out the pillar, which in horizontal mines should surround the structure equally on all sides. For the purpose of ascertaining the size of pillar, under normal conditions, for any depth and thickness of seam, the author gave the following empirical formula, based upon many examples of modern practice:

$$r = \frac{\sqrt{3d} \times \sqrt[3]{t}}{0{\cdot}8}$$

where d is the depth in yards, t the thickness excavated in feet, and r the radius of support in yards. In the case of mines inclined to, say, 30 deg., though the size of the pillar given by the formula was sufficient its position would not be vertically below the structure as in flat mines, but must be towards its higher side. The author had found that the line of break in such cases was neither vertical nor at right angles to the dip, but midway between the two. Thus, if the angle of dip be θ, the angle the line of break usually made with the horizon was $90 - \frac{1}{2}\theta$, and the lateral displacement in the direction of full rise of the seam, d being the depth, was represented by

$$d \text{ Tan } \tfrac{1}{2}\theta \text{ Cos } \theta.$$

Pillars of large area at depths of over 300 yards might with safety be partially worked or ribbed across by means of narrow banks or workings twenty yards wide, leaving solid pillars twenty or thirty yards wide between. This was found not to impair the strength of the support, the strata appeared to arch themselves over the worked portions, and there was practically no subsidence. This effected a considerable saving in the purchase of large pillars. In the case of bridges, where a succession of seams would probably be worked, it was necessary to consider whether the subsidence of level and possible rebuilding of the bridge, or the purchase of the mines for support in an increasing descending ratio, was the more economical or preferable.

Bridges with strong, well-bonded abutments and wings, and steel superstructure, were frequently worked under, and sustained little or no damage, especially in the case of deep mines. Where, therefore they must be built over an area to be subsequently mined, the intention being not to purchase support, they should be built in the manner described, and the girders should have a good bearing upon the beds. The subsidence to be expected, amounting to about two-thirds of the thickness excavated, should, if necessary, be provided for in the first height of the bridge; otherwise provision should be made for the eventual raising of the superstructure to its former level if required. Lofty viaducts should be protected by pillars; and lower structures should be built as indicated; the piers should be solid, and should not be pierced by an arch. In all cases, if possible, the goaf under the above should at the time of working be tightly packed.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

HEAVY purchases of pig iron are characterising the Midland and Staffordshire iron markets, and makers are in some cases declaring that they are already booked over April and May, and in one or two cases even up to August next. Common South Staffordshire forge iron is quoted 45s. sellers, and 47s. to 50s. foundry. Part-mines are 50s. for forge, and 55s. for foundry; and best all-mines 65s. to 70s. for forge, and 75s. foundry. North Staffordshire pigs are strong, sellers having a demand sufficient to absorb all their make in their own district. The Shelton Iron Company quote 53s. for forge, and about 56s. for Nos. 1, 2, and 3; whilst about the same was asked for Fenton produce. The Lilleshall Iron Company, Shropshire, quote hot-air all-mine pig 58s. 9d., and cold-blast selected chill roll iron 95s. to 97s. 6d. Messrs. Pound Brothers are understood to be asking 65s. for good quality hot air pigs. High prices are demanded for hematites. The Carnforth Hematite Iron Company quote 72s. 6d. to 73s. 6d. for No. 1; 71s. to 72s. for No. 2; and 71s. to 71s. 6d. for No. 3; while their forge iron was quoted 69s. American pig iron is quoted in the Midlands 50s. for forge, 52s. 6d. for No. 3., and 55s. for No. 1, with a good sale. Midland foundry iron is in excellent call. Derbyshire foundry iron is 52s. 6d. to 55s. for No. 3, and 60s. for No. 1; Northampton foundry iron is quoted, 51s. to 53s. for No. 3, and 56s. to 57s. for No. 1. Lincolnshire pigs are 50s. to 52s. for forge, delivered at stations in this district net, whilst mixed numbers of foundry pigs are 55s. to 57s.

Steel sheets for stamping and working-up purposes from South Wales were quoted to-day (Thursday) in Birmingham, £7 10s. for 24 w.g., £8 10s. for 26 and 27 w.g., and £8 7s. 6d. for 28 w.g. Some of the Staffordshire makers were asking 5s. per ton more. Annealed Siemens best sheets for deep stamping were £10 for 24 w.g., £11 for 26 w.g., and £12 for 28 w.g. Steel sheets finished suitably for enamelling and bright tinning were quoted by Midland firms £7 for 16 or 17 w.g. There is a large engineering demand for basic steel girders; singles at £6 5s. to £6 10s., and for plates at £7 to £7 5s.

A healthy and strong tone is maintained by manufactured iron. Galvanised corrugated sheets are £11 to £11 10s. f.o.b. Liverpool; marked bars, £8; second grade, £7 10s.; merchant bars, £6 15s. to £7; and common unmarked, £6 7s. 6d. to £6 15s. For black sheets, singles, £6 15s. to £6 17s. 6d. is asked, with £7 to £7 5s. for doubles, and £7 15s. to £8 for trebles. Nut and hurdle iron is £6 5s. to £6 10s.; and rivet iron, £8 10s. Channel iron is £7 10s. at works; sash iron, £7 10s. to £8 for basis sizes; and angles 5s. extra for ordinary sizes.

The copper market has still further "climbed down" this week from the pinnacle of a fortnight ago, and quotations are now about as here:—G.m.b. cash, £55 3s. 9d. to £55 8s. 9d.; three months about the same as cash; tough, £58 to £58 10s.; best selected, £59 to £59 10s.; strong sheets, £66.

At a mass meeting of the operatives engaged in the chain trade at Cradley Heath it has been decided to move early in the New Year for a 10 per cent. advance in wages.

The South Staffordshire Mines Drainage Commissioners have approved this week a report of the Sub-committee on the new electrical scheme. This shows that steps have been taken for the best available design or designs for a semi-portable pump for mines drainage purposes, to be laid before the Committee at their next meeting; and that the proposal to borrow £10,000 at once for gravity works upon the surface, and £10,000 for electric pumps on the surface when electric power is available, was approved. The chairman and general manager have been empowered to take the necessary steps with a view to the suggested arrangement being carried into effect.

The Parliamentary Committee of the Warwickshire City Council have been instructed to investigate and report upon the proposal to construct a railway from Reading to Coventry, as also upon any other scheme for improving the railway facilities of the city. The General Works Committee of the Council have accepted the tender of Messrs. Wingrove and Stanley, of Northampton, amounting to £11,276, for the erection of pumping station and buildings in connection with the Lodge Farm sewage-disposal scheme.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Throughout the engineering trades of this district the very satisfactory position reported for some time past is being fully maintained. In isolated cases some slackening off is reported, but in most cases this is due mainly to special circumstances that have no direct relation to the actual condition of trade. The leading establishments connected with the principal branches of engineering, such as machine tool making, stationary and locomotive engine building, boiler making and all sections of hydraulic and electrical engineering, are mostly full of work to carry them well over next year, and generally report new orders offering in larger quantity than they can entertain, at any rate to comply with requirements of delivery put forward by their customers. All branches of the iron and steel trades also maintain a sound, healthy position, but the impression seems to be gaining ground in some quarters that the maximum point as regards prices has been touched, and one or two of the speculative operators are showing a disposition to undersell for delivery next year. The opinion generally, however, is that any easing down in prices, such as the weakening in warrants during the past week, can be only temporary, and in most cases merchants are very cautious about entering into anything like low-priced engagements, whilst makers and manufacturers of both iron and steel are mostly so fully booked into next year that they are indifferent about new orders, and certainly there is no inducement at present to entertain business at anything under their full rates.

A steady business was doing on Tuesday's iron market at Manchester, but the general tone was scarcely so strong as recently. Here and there representatives of pig iron makers reported only a very small weight of orders offering, whilst finished iron manufacturers did not appear to be securing new work quite so freely as of late, and merchants in some instances complained that specifications from customers on account of contracts were not coming forward very satisfactorily. Taking business all through, however, there was a very fair inquiry for pig iron, and although in the open market prices were rather easier, where some low quotations mentioned for delivery next year, there was no real giving way on the part of makers except that they were perhaps not holding to the special and practically prohibitive quotations which some of them were a week or two back quoting very firmly where any new inquiries came forward. For Lancashire foundry pig makers are firm at 53s. 6d., less 2½, but district makers have scarcely succeeded in establishing the full prices they have been asking, and where business is actually done, Lincolnshire could hardly be quoted above 52s. for foundry, with Derbyshire ranging from 52s. 6d. to 54s. net delivered Manchester. For forge qualities there is not that rush of inquiry which was noticeable last month, but except to the extent already referred to, prices are well maintained. For Lancashire forge pig iron makers are not quoting under 49s. to 49s. 6d., less 2½d, with Lincolnshire 48s. 6d. to 49s. net delivered Warrington. Middlesbrough is easier, 54s. 4d. net by rail Manchester being the average quotation for prompt delivery, with sellers at quite 1s. under this figure for delivery net year. Scotch iron remains firm, owing to the small stocks at the Lancashire ports, and the difficulty in obtaining vessels; delivered Manchester docks, Glengarnock could scarcely be bought under 54s. 6d. to 54s. 9d., and Eglinton 55s., with American pig iron, of which fairly large quantities are arriving, 50s. to 52s. net.

In the finished iron trade bars meet with a satisfactory demand, and the minimum quotations are £6 10s. for Lancashire and Yorkshire to £6 15s. for North Staffordshire qualities delivered here. Sheets are only in moderate request at about £7 5s., and in hoops business is slow, but list rates unchanged at £7 for random to £7 5s. for special cut lengths delivered Manchester district, and 2s. 6d. less for shipment. Nut and bolt makers have put up list rates 10s. per ton, and are getting the full prices on new business.

A strong healthy tone is maintained in the steel trade, but prices are without material change. Hematites are steady at 65s. 6d. to 66s. 6d., less 2½. Local billets are perhaps scarcely firm at the full quotation of £4 15s. net, but all descriptions of manufactured material fully sustain the recent advance, steel bars averaging £7 to £7 5s., with plates, which show a continued hardening tendency, quoted £7 2s. 6d. to £7 7s. 6d. for common, and £8 2s. 6d. to £8 5s. for boiler-making qualities, delivered in this district.

Mr. Stephen Wrightson, who has occupied the position of Secretary to the Carnforth Hematite Iron Company, Limited, for the last thirty years, died very suddenly at his residence on Saturday last.

The condition of the coal trade here shows further very satisfactory improvement. Notwithstanding the continued exceptional mildness of the season, all descriptions of fuel are in active request, with pits generally working an average of ten to eleven days per fortnight, and all the output going away. Although there is no actual pressure on the better qualities of round coal suitable for house fire purposes, the absence of stocks at many of the large collieries, which have usually to be drawn upon at this time of the year, throws the demand almost exclusively upon the output, which is not more than sufficient to meet present requirements, and prices are exceedingly firm at the full list rates. For the lower qualities of round coal there is also an active demand both for inland requirements and for shipment, which is taking away all this class of fuel that is coming upon the market, and prices are tending to harden, good qualities of steam and forge coal for inland sale fetching from 7s. 9d. to 8s. 3d., whilst for shipment, orders for which have been increasing during the past week, prices are stronger, 9s. to 9s. 3d. being about the minimum for ordinary qualities of steam coal, with some special sorts fetching 9s. 6d. up to 10s., delivered Garston docks or High Level, Liverpool. The pressure of demand reported last week for all descriptions of engine fuel is fully maintained, the advance in prices having in no way checked inquiries coming forward, and the full rates have been obtained without difficulty. It is only in exceptional cases where the commoner sorts of slack are quoted anything under 4s. to 4s. 6d., with good medium sorts 4s. 9d. to 5s., and the best qualities 5s. 3d. to 5s. 6d. at the pit mouth. There is a large inquiry for coke, and prices have shown a considerable advance during the last two or three months, 16s. being now readily got for Lancashire coke at the ovens.

Barrow.—The hematite pig iron trade is very brisk, and orders are coming in freely from all sources; but makers are not in a position to accept orders for early delivery, and they are very well sold forward on immediate account. Makers are quoting 58s. to 58s. 6d. per ton for parcels of mixed Bessemer numbers, net f.o.b.; while warrant iron is at 57s. 1½d. net cash, sellers; 57s. 1d. buyers. Stocks have been further increased during the week by 2850 tons, making the stock in hand 138,163 tons, or 46,287 tons less than at the beginning of the year. Makers are blowing forty furnaces, as compared with forty-one furnaces in the corresponding week of last year. There is not much doing in forge or foundry iron, and business in these qualities is naturally quiet when prices are high.

Iron ore is in very brisk demand, and the output is still very much below the needs of consumers. Prices are steady at 14s. per ton for good average qualities net at mines. Common sorts are quoted at 11s. per ton, and best descriptions are selling freely at 17s. 6d. per ton. Spanish iron is selling at 17s. 6d. per ton net at West Coast ports.

Steel makers are very briskly employed, and orders are coming to hand freely from all sources. The rail trade is well employed, and makers are well off for orders, and are likely to remain so for some time to come. Heavy rails are brisk at £4 12s. 6d., while heavy steel plates are in brisk request at £6 15s. per ton, and orders are very plentiful. There is a good business doing in billets, tin-plate bars, hoops, and heavy steel castings.

Shipbuilders and marine engineers are very busy, and orders are plentifully held. There is every prospect of a very good business in the future, as inquiries are strong, and prospective orders are alike good and numerous. Marine engineers are very busily employed, and orders are coming in freely from all sources, with the result that the shops are not only very fully employed, but are likely to be even more so in the immediate future.

Coal and coke are in very good demand, and prices are high and firm.

The shipping trade at West Coast ports is very briskly employed. Last week 8520 tons of pig iron and 11,780 tons of steel were shipped, as compared with 7100 tons of pig iron and 7430 tons of steel in the corresponding week of last year, showing an increase of 1420 tons of pig iron and 4350 tons of steel. The total for the year now amounts to 491,572 tons of pig iron and 496,525 tons of steel, as compared with 411,982 tons of pig iron and 437,796 tons of steel in the corresponding period of last year, showing an increase of 79,590 tons of pig iron and 49,728 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE pits in the South Yorkshire coal district continue to work steadily, and large as the output is, there is a market for every ton of it. The district is thus in the happy condition that, although the tonnage brought to bank is exceptionally heavy, the stocks at the pits have rarely been so light as they are at present. Colliery owners complain somewhat that the men do not work as they might do, and in three or four districts it is stated that their neglect has the effect of increasing the working costs by at least 10 per cent., through the number of places which have to be kept in working order being larger than would otherwise be required. The recent short snap of cold weather has caused house coal to be in greater demand, and although mildness has again set in, the season is too far advanced to run any risks, and householders will not further delay completing their winter supplies. This accounts for a good tonnage being forwarded to London, and a brisker aspect put upon the house-coal trade all round. The demand previously noted for secondary grades of coal is sustained. Best Silkstones are this week quoted 9s. to 10s. per ton; ordinary from 8s. per ton; Barnsley house, 8s. 6d. to 9s. per ton; seconds, from 7s. per ton.

For steam coal the demand continues very brisk, the railways being very large customers, their requirements much exceeding the quantities contracted for, while the activity in the iron trade necessitates larger supplies. These circumstances, coupled with the prolongation of the export business through the Baltic ports being kept open later than usual, all combine to make steam coal very firm. Values are steady at 8s. to 8s. 6d. per ton; for Barnsley hards, seconds from 7s. per ton. For engine fuel Lancashire and the manufacturing towns of the West Riding continue to be exceptionally heavy customers. Nuts are at 6s. 6d. to 7s. 6d. per ton; screened slack from 5s. per ton; pit slack from 3s. per ton. The exceptional call for coke previously noted continues to be fully maintained, the demand for North Lincolnshire being especially noteworthy, and likely to be increased. Best qualities of coke have been sold at from 12s. to 13s. per ton, ordinary coke being about 2s. less.

In the heavy trades the whole of the plant and machinery is actively employed, and energetic work is proceeding with a view of increasing the output, more particularly in armour plates, in which the three firms employed in this important speciality are now engaged in extensions which will cost several hundred thousand pounds. In all the railway branches, with the exception of steel rails, work is abundant. The wagon firms are full up, and orders are constantly coming in, while the manufacturers of nuts, bolts, and other accessories have so much work in hand that they are not greatly concerned about further orders this side of 1899, and anything now being taken will not be for immediate delivery. A feature of local trade at present is the demand for iron pipes for carrying electric cables and telephone wires, as well as for gas and water mains. In regard to the iron trade, which continues exceptionally brisk, it is rather surprising that values do not rise quicker than they do; but as iron is scarce, and stocks, alike in the hands of makers and consumers, are very light, it is extremely probable that several blast furnaces which have long been idle may soon be re-started; and, in fact, this step has already been taken in some directions. It is gratifying to know that the greater weight of iron now being made is on account of home work, chiefly in respect of shipbuilding, railway material, and pillars and girders for building contractors.

Mr. W. T. Lemmon, of the Constructor's Department, Portsmouth Dockyard, has accepted an appointment from Messrs. John Brown and Co., Atlas Steel and Ironworks, Sheffield.

In the general run of the lighter industries there is a good deal of work in hand, but it is very unequally divided. The larger firms in the cutlery and silver trades are well employed, but several of the smaller houses are by no means pressed with orders. The Christmas and New Year requirements are likely to be below the average, owing chiefly to the indifferent business done last season, when a good deal of stock was left unsold.

The Midland Railway Company have acquired a considerable area of land in the Abbeydale district, a short distance from Sheffield, for the construction of carriage works. The site is near Ecclesall, one of their stations on the main line, two and a-half miles from Sheffield.

NORTH OF ENGLAND.

(From our own Correspondent.)

WHILE the manufactured iron and steel trades, the shipbuilding, the engineering, and all the industries allied thereto, are almost unprecedentedly prosperous, and have excellent prospects for next year, the pig iron business is dull, there being comparatively few sales. This, however, is one of the results of the artificial state of affairs brought about in October and November by the "rig" in Cleveland warrants. There was bound to be a re-action, and buyers have not recovered confidence after the disorganisation that was brought about. They buy from hand to mouth, and wait to see how far prices will drop for pig iron. There is now some reason to believe that the bottom has been reached; at any rate, the prices have been more settled this week than for over two months, No. 3 having remained at one figure nearly all the week, which, as things have been, is a somewhat long period for quotations to be stationary. Merchants have been asking 45s. per ton for prompt f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron, and buyers have been paying this. Makers have quoted 45s. 6d., and they would accept this not only for prompt, but also for spring delivery, and they have sold at the figure for delivery over the first quarter of 1899. Cleveland warrants have kept about 45s. per ton cash, sellers; this is 7s. per ton less than was paid during the latter part of November, when the "rig" was coming to a close, when some holders of warrants asked 54s. The price of warrants is still 2s. per ton above the figure that ruled when the recent speculative movement commenced, and is 5s. above the price that ruled in the summer. No. 1 Cleveland pig iron is sold at 46s. 6d.; No. 4 foundry at 44s. 6d.; grey forge at 42s. 9d.; mottled, 42s. 3d.; and white, 41s. 9d.; but 3d. per ton more has been realised by some firms for No. 4 foundry and white, as these qualities are rather scarce.

Mixed numbers of East Coast hematite pig iron are quoted at 55s. per ton, though some makers will not sell under 55s. 6d., as cost is increasing. Rubio ore is stronger in price, on account of the disquieting news from Spain anent a probable revolution of the Carlists. That would interfere very seriously with the ore trade, because the chief seat of the war would almost certainly be among the mountains of Asturias in the neighbourhood of the largest ore mines. The North of Spain is the district in which the Carlist faction finds the most supporters. In the civil war which lasted from 1872 to 1876 the ore trade was very much hampered, though it was of small extent compared with the industry as now carried on. Consumers here, in view of the state of affairs that is being developed, have ceased to draw largely on their heavy stocks of ore, but are importing more freely, and are paying 15s. per ton for average Rubio delivered in this district.

This month shipments of pig iron from the Cleveland district are somewhat better than they were during the latter part of November, and up to the 7th they reached 18,630 tons, as compared with 19,445 tons last month, and 18,458 tons in December, 1897, to 7th. Less iron is going into Connal's stores, since the necessity for making warrants has disappeared. On Wednesday night Messrs. Connal and Co. held 125,392 tons of Cleveland pig iron, an increase for the month of 1648 tons, while of hematite pig iron they had 35,711 tons, a decrease for the month of 947 tons.

As stated last week, the shipments of pig from the Cleveland district during November were poor. The lessened trade was nearly all with the Continent, Cleveland iron getting to a price which was too high for it to be profitably used abroad, as native iron was considerably cheaper. To Germany only 21,938 tons were sent, as compared with 36,989 in November, 1897; France had only 730 tons, against 2680; Belgium 1775, against 3061 tons; and Italy 3650 tons, against 7879 tons. The eleven months' exports fell short of those of 1896 and 1897, but exceeded those of any other year. They amounted to 1,035,908 tons, this being 133,111 tons, or 11½ per cent. less than last year. The chief decrease was in the deliveries over sea, which reached 541,586 tons, or 116,640 tons (18 per cent.) less than in 1897, while the coastwise deliveries were 494,052 tons, decrease three per cent. Last year Germany had in the first eleven months 363,290 tons of pig iron from the Cleveland district, this year only 285,729 tons; Belgium's receipts were 27,463 tons this year, as compared with 52,308 tons last year; France's 29,459 tons, as compared with 38,290 tons. To Scotland 382,024 tons have been sent, only 1400 tons less than last year.

The manufactured iron and steel industries are unprecedentedly brisk, and the production could easily be larger if the works were equal to it, for more orders are offered than the manufacturers can really undertake. Further than this, most firms have enough work on their books to keep them fully occupied for the whole of next half year, and it is extremely difficult to procure either finished iron or steel for anything like early delivery. Manufacturers seem to be doing consumers a favour where they accept orders, even when premiums on the regular market prices are paid. The prospects for 1899 are most encouraging, and there is every reason to believe that next year trade will be more prosperous than it has been even this year. The sellers have now pretty much their own way in regard to the regulation of prices, and foreign competition is of small account, because enough work can be had from home consumers to render producers largely independent of continental business at least. There is no cause for complaint in regard to the business with our Colonies. The combination of steel plate makers have advanced their minimum price of steel ship plates to £6 15s., less 2½ per cent., but they are all so full of work that it is scarcely possible to buy at that figure, most producers quoting 2s. 6d., and some 5s. more than the minimum above named. For steel boiler plates £7 5s. is the minimum; for iron ship plates £6 10s. Steel ship angles £6 10s. is now asked; for iron ship angles £6 2s. 6d.; for common iron bars £6 2s. 6d. All the above-

named prices are less 2½ per cent. discount, and are f.o.t. Steel sheets, singles, have been advanced half-a-crown, and are now at £7 17s. 6d., less 2½ per cent. Manufacturers of sheets in this district, both black and galvanised, are much better off than their competitors in Staffordshire; they are very well booked for some months ahead. Heavy steel rails are firm at £4 12s. 6d.; cast iron chairs, £3 5s.; and steel sleepers, £5 17s. 6d., all net at works. The Erimus Steel Works, between Stockton and Middlesbrough, have now been completely dismantled, and the site is to be utilised as a timber yard by the owners of the Middlesbrough Estate, whose present yard is required by the North-Eastern Railway Company in connection with the enlargement of Middlesbrough Dock.

At this week's meeting of the Tees Conservancy Commissioners a very important scheme of railway extension was announced, viz., a railway along the north bank of the Tees over the reclaimed land similar to the line on the south side of the river. This will open up excellent sites for new works. The Commissioners will make the railway and also a roadway from Greatham Creek to Billingham Beck, and the North-Eastern Railway Company will continue the line from Billingham Beck to Stockton, where it will terminate by a junction with the company's Stockton and Hartlepool branch, near to Messrs. Blair and Co.'s engines works. The North-Eastern Railway Company will hereafter continue the line from Greatham Creek to Hartlepool. The Corporation of Stockton will construct a road from Billingham Beck to Stockton by way of Portrack in continuation of the Tees Commissioners' road. It is expected that the North-Eastern Railway Company will commence the construction of the line from Stockton to Billingham Beck next spring. There will thus be offered facilities for establishing shipbuilding yards, chemical works, ironworks, &c., on the north side of the Tees, similar to those existing on the south side.

The shipbuilding industry is very active, and more orders are offered than the builders can undertake. Messrs. Wigham Richardson and Co., Newcastle-on-Tyne, have just booked an order for a twin-screw steamer of 10,000 tons for the North German Lloyd Company, and also a single-screw steamer. Both vessels will be fitted with quadruple-expansion engines, working to 210 lb. pressure, on the Yarrow, Schlick, and Tweedy system. Sir W. G. Armstrong, Whitworth, and Co. are reported to have received an order for another ice breaker for Northern Russia. They are also to fit the guns and torpedo tubes on the Japanese cruiser Kosagi, which has been built by Messrs. Cramp, of Philadelphia. Messrs. Jno. Blumer and Co. are about to extend their shipyard at Sunderland, as are also Messrs. William Doxford and Sons.

The coal trade is generally satisfactory, there being much more business passing in the steam-coal branch than is usual at this season of the year, and so well are the coalmasters supplied with orders for this month's execution that they have very little coal available for sale for this month's delivery. Collieries are very well employed, there being little lost time in view of the approaching holidays. Best steam coal is about 9s. 9d. per ton f.o.b.; smalls, 4s. 9d.; best gas coal, 8s. 6d. to 9s. f.o.b. Shipments are heavy. Coke for next half-year's delivery averages 15s. 6d. per ton, delivered at the Middlesbrough furnaces. At Pegswood Colliery a new seam of coal, 7ft. thick, has been found, and a new shaft is being sunk to work it.

The death, at the age of eighty-six, is announced of Mr. William Salkeld, who was long connected with survey work in connection with railways. He took part also in the survey for the Tithe Computation Commission, in 1834. He made the preliminary survey for the Carlisle and Penrith section of the Lancaster and Carlisle line, now part of the London and North-Western system. After that he was engaged on the survey for a projected extension of the Stockton and Darlington Railway, through West Durham into Cumberland. Afterwards he became one of the permanent staff in the engineering department of the Stockton and Darlington Railway Company, and in that capacity he was engaged surveying for several of its extensions. When the Stockton and Darlington was amalgamated with the North-Eastern Railway, in 1873, Mr. Salkeld continued his connection with the Darlington office, and retired about twelve years ago.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

So far as the warrant market is concerned, business in pig iron has been unsatisfactory this week. The recent squeeze in the Cleveland branch of the market is still severely felt. Indeed, scarcely any business is being done in Cleveland warrants in the open market. A few transactions have taken place at 44s. 10½d. to 44s. 9d. for delivery in ten days, but there have been practically no cash sales of Cleveland warrants.

The market for Scotch warrants broke away rather badly towards the end of last week, and prices again went considerably lower in the early part of the present week.

The position of the manufacturing branches, however, is so favourable that it is thought prices will almost certainly go higher. Business has been done in Scotch warrants from 49s. 6d. to 49s. 0½d. cash, and 49s. 9½d. to 49s. 3½d. one month.

The market for Cumberland hematite opened very dull, but there was afterwards some improvement, although, upon the whole, prices for warrants have been lower. Sales have been made at 57s. 1½d. to 56s. 10d. cash, and 57s. 5d. to 57s. 0½d. one month. A long time has elapsed since there was any business in this market in Middlesbrough hematite, but this week a few lots have changed hands at 55s. down to 54s. 9d. for delivery in ten days.

Scotch hematite meets with a strong and steady demand, the output having been increased since last report by about 600 tons per week. Prices of this iron are quoted by merchants at 60s. 6d. per ton for delivery in railway wagons at the steel works.

The prices of the special brands of makers' iron are somewhat higher, the values of the common brands being, of course, regulated by the fluctuations in warrants. Monkland and Govan are quoted f.o.b. at Glasgow, Nos. 1, 50s. 1½d.; Nos. 3, 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 48s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Gartsherrie, Nos. 1, 56s.; Nos. 3, 51s.; Calder, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Coltness, No. 1, 58s.; No. 3, 51s. 6d.; Glengarnock at Ardrossan, No. 1, 55s.; No. 3, 50s.; Eglinton at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Dalmellington at Ayr, No. 1, 51s. 6d.; No. 3, 50s. per ton; Shotts at Leith, No. 1, 56s.; No. 3, 51s.; Carron at Grangemouth, No. 1, 56s.; No. 3, 51s.

The shipping demand for Scotch pig iron does not improve, and it is fortunate that there is such a good sale for consumption at home. In the past week the quantity despatched was 3190 tons, against 2685 in the corresponding week of last year. To Holland 240 tons were despatched, Germany 230, Russia 160, India 100, United States 25, Australia 10, France 65, Belgium 30, China and Japan 152, other countries 50; the coastwise shipments being 2135 tons, compared with 1750 in the corresponding week.

For malleable iron there is a steady market, and a comparatively good business is being done. Common bars are quoted £6 17s. 6d., and best bars £7 5s. per ton, less the usual 5 per cent. for cash in one month.

The demand for steel is ahead of the current means of supply; which means that in not a few instances deliveries are in arrear. Inquiries are numerous, and the prospects altogether highly favourable. Mild steel angles are quoted £6 10s.; tees and bars, £7 10s.; ship plates, £7; and joists, £6 5s. per ton, all less the usual 5 per cent. discount for delivery in the Clyde district.

There is an active business in the coal trade; but great inconvenience is being experienced from want of an adequate supply of railway wagons to transmit the coals. The current quotations at Glasgow Harbour are:—Main coal, 8s. 3d. to 8s. 6d.; steam, 9s. 9d.; ell, 9s. 3d. to 9s. 6d.; splint, 9s. 9d. to 10s. per ton.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE animation in the steel trade is being attended with large imports of ore from Spain. There has also been an increase in pig iron from Spain, principally to Swansea, and some consignments of steel bar from the Baltic for Newport. The principal cargoes of pig iron that came in last week were from Ulverstone and Ardrossan. Old rails were also received from Southampton and Bridgwater. The list of miscellaneous imports to the Welsh ports included quantities of scrap iron from Cornwall, Aberdeen, and London to Briton Ferry, 1750 tons iron pyrites to Swansea, and spiegel from Mostyn, North Wales, to Dowlais. I have referred in the past to great and unworked tracts of manganese in North Wales, which may yet prompt a rather flagging industry.

In the Swansea Valley last week the output of steel was exceptionally heavy. This was chiefly due to the re-starting of the Upper Forest Steelworks. At least 1500 tons of steel bars were rolled last week in excess of the total for the same period last quarter. Bars have also figured largely at the Bessemer works of the hills, Cyfarthfa being very marked. I have not heard of further iron and steel shipments to Wales from America. Rails to Ireland and pipes to London figured in last week's consignments, but none to Wales.

During the month the prices of bar have gone up 2s. 6d. per ton, prices closing at £4 15s. for Bessemer steel.

On 'Change, Swansea, mid-week, business was animated, and buyers were present from London and the Midlands. Pig iron was stated to have fallen off on the week to the extent of 6d. per ton in Scotch, 1s. per ton in Middlesbrough, and 1s. 1½d. per ton in hematite. It was reported that the finished iron and steel branches of trade had been affected by the fall in pig iron, and that sellers showed a greater desire to enter orders for forward delivery, but that hitherto buyers had held off in the expectation that with the decreased value of pig iron a corresponding reduction would take place in tin-plate bars. The Bessemer steel works were stated to be fully employed on rails and billets, and to be quoting 5s. higher prices.

Closing figures are as follows:—Glasgow pig iron warrants, 49s. 3d. to 49s. 2d. cash buyers; Middlesbrough No. 3, 44s. 10½d. prompt; hematite warrants, 56s. 11d. for mixed numbers f.o.b. Cumberland, according to brand; Middlesbrough hematite, 55s.; Welsh bars, £8 7s. 6d. to £8 10s.; angles, &c., at usual extras. Sheet iron and steel sheets, £7 to £7 2s. 6d. Steel rails: Heavy sections, £4 15s. to £4 17s. 6d.; light, £5 to £5 12s. 6d. Bessemer steel: Tin-plate bars, £4 12s. 6d. Siemens bars: Best, £4 15s., all delivered in district net cash. Tin-plates: Bessemer steel cokes, 10s. 9d. to 11s.; Siemens, 11s. to 11s. 3d.; ternes, 19s. 3d. to 21s. 6d.; best charcoal, 12s. 9d. to 13s.; finished black plates, £8 to £8 10s.; Canadas, £7 to £7 10s. Block tin, £81 6s. 3d. to £81 16s. 3d.; lead, £13 7s. 6d.; Spanish, £13 5s.

Tonnage did not come into Cardiff last week quite so freely as desired, and this caused a slightly diminished export; yet the tone of the trade continues vigorous, and coalowners would seem to be holding back, in order to improve prices. Steam coal shipments from Cardiff to coaling stations continues very marked, and to France are well maintained. On one day last week 14,100 tons went to Port Said. This week, again, on the 5th, 4300 tons were despatched to Port Said, 5000 tons to Singapore, 4300 tons to Aden, and 3000 tons to Malta. India is buying largely. In anthracite some noticeable shipments have been made to London, from the Great Mountain Colliery, Llanelly. Good coal business appears certain at all the Welsh ports up to the end of the year.

Notices of contracts may now soon be expected. I am informed that those with the Cunard line are being made.

Pitwood is ruling a little easier, large cargoes coming to hand.

Prices remain much the same. In smalls there are signs of higher figures, and any day this may be the case with best large steam. Closing figures, Cardiff, this week were as follows:—Best steam, 13s. to 13s. 6d.; seconds, 11s. to 12s. 6d.; drys, 10s. 6d. to 10s. 9d.; best Monmouthshire, 10s. 9d. to 11s. 3d.; seconds, 9s. 6d. to 10s.; special steam smalls, 6s. 3d. to 6s. 6d.; best ordinary, 5s. to 5s. 6d.; seconds and inferior, 4s. 3d. to 4s. 6d.; best households, 13s. to 14s.; No. 3, Rhondda, 12s. 6d. to 13s.; No. 2, Rhondda, 8s. 6d. to 9s.; smalls, 5s. to 5s. 3d. Swansea prices:—Anthracite, 14s. to 14s. 6d.; seconds, 12s. 6d. to 13s.; ordinary, 11s. to 11s. 6d.; small rubbly culm according to position on stem. Steam coal, 11s. to 11s. 3d.; seconds, 9s. 6d. to 10s. 3d.; bunkers, 7s. 9d. to 8s. 3d.; small, 4s. 6d. to 5s. 9d. Bituminous coal: No. 3, Rhondda, 12s. 6d. to 13s.; No. 2, 9s. 9d. to 9s. 6d.; through, 7s. 9d. to 8s.; small, No. 2, Rhondda, 5s. to 5s. 6d., all delivered Swansea, cash, thirty days, less 2½. Patent fuel, 10s. 9d. to 11s. Cardiff prices, 11s. to 12s. At both ports this is in good demand. Cardiff last week sent 3300 tons to Vera Cruz, a large quantity to Genoa and to Puerto Capello. Coke is active; Cardiff prices, 16s. 6d. to 17s. 6d. for furnace, 18s. 6d. to 24s. 6d. foundry, according to quality.

I am informed that the Great Western railway management contemplates a connection with Nantyglo and district. This would seem to an outsider rather late in the day, considering that this was the scene of Evanshay Bailey's success almost half a century ago as an ironmaster, and the subsequent attempt to re-start the whole concern by a company. But the old ironmasters were not great in coal working, and doubtless there is a good future yet in that neighbourhood, together with a large tin-plate industry, &c. The enginemen of the Cardiff district are agitating for a schedule of standard wages to be adopted by coalowners. There is a dispute at the Californian Collieries, East Bristol, and the manager has given orders to terminate contracts, which will expire on Saturday.

In the "restless district of Llanelly" the "cold roll boys" at the Old Castle Tin-plate Works, to the number of fifty, struck work on Monday, and did not return on Tuesday. It is feared that unless a speedy settlement is brought about, the whole works may be closed.

The production of tin-plate last week at Swansea was considerably in excess of shipments; receipts from work 64,269 boxes; shipments 31,492 boxes; present stock 201,763 boxes, compared with 106,831 boxes this time last year. The outlook at Swansea is recorded as brighter. Ten mills are now at work which have been standing some time. The whole of the mills at Upper Forest are now at work; Foxholes, all busy. The tin-house department at Glantawe is idle owing to a dispute, and the millmen are on day-by-day contracts.

Experiments are still carried on with the revolving calcining furnace at Llansamlet Lower sulphide ore establishment, and the metal is being sent to London for analysis.

A fair average business in tin-plate, steel bar, and ingot is being done at Briton Ferry.

At Llanelly regular work is going on, and the repairers are busy at Morewoods, but no start is announced. A project is on foot for reforming the "Union." Wages questions are relegated to the spring.

The resignation of Mr. John Boyle, chairman of the Rhymney Railway, has been announced. In connection with the Bute Trust, and in the early days of the Rhymney Railway and its conflicts, and generally interesting career, he has been a leading mind, vigorous and to the front until advancing years necessitated first lessened action, and then withdrawal.

The late audit of the sliding scale declares an advance to the colliers of 2½ per cent. This, with the 5 per cent. granted, now makes the colliers' condition 7½ per cent. better than in April last. If good, steady work be persisted in, there is every likelihood of improving wages. At the audit some objection was raised to the irregular election of the working men's section of the scale. This will again be brought to the front.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE brisk business already reported in previous letters continues on the Rhenish-Westphalian iron market; in all departments full employment is maintained; and though output increases, buyers in many cases are experiencing considerable difficulty in obtaining the supplies they want. Makers of pig iron and the producers of blooms and ingots find themselves frequently unable to meet the requirements of their customers, and sales in raw material of English or American make have again been pretty extensive.

Bars and plates are in vigorous demand, and the trade in all sorts of structural iron is brilliant. Foundries, machine and wagon factories are all very busy, and hopes are expressed that the satisfactory position in these departments will further increase. Next month an order for 300 locomotives will be given out by the Prussian State Railways, and within the course of next year no less than 1000 locomotives are to be ordered, so that the shops are indeed looking forward to a lively period. If the prices obtained are not extraordinarily good, they are at least paying and firm; and, moreover, a rise may take place soon, the present fair position of the market causing a hopeful upward tendency throughout the iron trade.

There is a brisk business doing in Silesia in raw and in manufactured iron. The rolling mills of Upper Silesia have officially raised the basis export quotation for bars M. 5 p.t.

The coal trade in the Rhenish-Westphalian, Silesian, and Saar districts keeps exceptionally brisk, especially where engine classes of fuel are concerned. The mild weather of the last few weeks has caused the demand for house coal to decrease slightly.

The Austro-Hungarian iron business is in much the same state as before, a very moderate demand coming in for raw and finished iron. Bars have here and there been offered at reduced rates; in Prague, for instance, they are reported to have been sold at 95 fl. p.t., while in Budapest even less was asked. The machine and locomotive shops, which have been satisfactorily engaged until now, are likely to remain well employed for some time ahead, the Kaiser Ferdinand Nord Bahn having given out twenty-six locomotives and 920 load cars. The Austrian Lloyd contemplates the building of three large steamers of 4000 t. carrying capacity, for the Levant service; this will help to keep a good many works in regular activity for some time, as all the iron and steel required is to be supplied by inland firms.

The demand for structural material has shown a falling-off on the Bulgarian iron market, but for other articles of iron and steel a regular inquiry was coming forward during this week and last; supplies from Austria-Hungary are fairly large. In merchant iron 1330 q. have been imported from that country, while 1020 q. were bought in Germany. There was a specially good inquiry noticed for cast iron stoves. The wire nails imported (214 q.) came from Germany.

A very limited trade was done in iron to Servia, only one wagon hardware and two wagons wire nails from Austria-Hungary having been imported during the past few weeks.

The Belgian iron industry is, generally, very active. Nearly all branches report an improving tendency, both as regards demand and quotations. Export has been steadily increasing of late, and pretty good prices are being realised.

The reports given of the French iron market are, on the whole, satisfactory, employment in the various departments of the iron and steel industries being lively, if not very brisk. Large sales have not been effected upon the week, but there is a steady tone maintained all through. Quotations for bars are still the same as before, 160f. to 165f. p.t. being quoted, while girders remain at 175f. to 180f. p.t., Paris.

ROYAL INSTITUTION.—A general monthly meeting of the members of the Royal Institution was held on the 5th inst., in the afternoon, Sir James Crichton-Browne, M.D., F.R.S., treasurer and vice-president, presiding. The following were elected members:—Mr. Herbert William Allingham, F.R.C.S.; Mr. T. Newbold Piddocke; Mr. Edward Preedy; Mr. William Munro Tapp, LL.D.; the Hon. William Frederick Cuthbert Vernon; Mrs. Adela Wetzlar, and Dr. Charles Theodore Williams, F.R.C.P. The special thanks of the members were returned to Dr. George Wyld, for his present of a portrait of Dr. Thomas Garnett, first Professor in the Royal Institution.

THE AUTOMOBILE CLUB OF GREAT BRITAIN AND IRELAND.—Forthcoming arrangements:—Thursday, December 8th, 1898, at 8.30 p.m., ladies' concert. Wednesday, December 14th, 1898, at 7.30 p.m., house dinner, at which Mr. B. Redwood, F.R.S., will preside; discussion on "The Practical Working of the Benz Motor," to be opened by reading a paper by Mr. John Henry Knight. Wednesday, January 11th, 1899, at 7.30 p.m., house dinner, Mr. W. H. Preece, C.B., in the chair: discussion on accumulators, to be opened by the reading of a paper, entitled "Some Notes on the Employment of Accumulators in Electrically-propelled Vehicles," by Mr. Percy Northey. Wednesday, February 8th, 1899, at 7.30 p.m., house dinner; 9.0 p.m., paper and discussion. Wednesday, March 8th, 1899, at 7.30 p.m., house dinner; 9.0 p.m., paper and discussion. Mr. R. E. B. Crompton has promised to open a discussion on "Traffic Regulations," and Mr. Lyons Sampson on "Brakes," but dates have not yet been fixed for the events.

THE PATENT LAWS.—The monthly dinner and debate of the Article Club were held at the Trocadero Restaurant last night, Mr. J. Fletcher Moulton, Q.C., M.P., presiding. The subject of the after-dinner debate was "The Patent Laws and the Trading Community." Among the company present were Lord Justice Vaughan Williams, Lord Suffield, Mr. McKinnon Wood, chairman of the London County Council, Sir A. Noble, Sir H. Tozer, Agent-General for Queensland, the Hon. E. H. Wittenoom, Agent-General for Western Australia, the Hon. E. Blake, Q.C., M.P., Sir A. Sullivan, Mr. C. N. Dalton, Controller of Patents, Mr. W. Murton, of the Board of Trade, Mr. Alexander Siemens, Mr. J. Cutler, Q.C., Mr. C. M. Warmington, Q.C., Mr. R. W. Wallace, Q.C., Mr. Lewis Edmunds, Q.C., Sir J. R. Heron Maxwell, Mr. J. Scott Wood, and Mr. Lesser Columbus, hon. secretary. The toast of "The Queen" having been honoured, the Chairman said that they had to consider, not the use, but the abuse of the patent laws. Many people held that the real evils to the trading community were the patents which were held *in terrorem* over the heads of subsequent inventors. It was unquestionably a matter of serious interest to the trading community that trading should go on, not only uninterfered with, but that this system of threatening should not be carried on with impunity, and he thought the state of things would be intolerable if there was not some remedy for this misuse of patent rights. He thought, however, that one addition to the remedy under Section 32 of the Patent Act would be effective. A little more should be done in the way of empowering the Courts to make what he might call sensible arrangements by which justice might be done after the rights had been settled. He also referred to the case of people living abroad who took out patents in England, by which new manufactures were sometimes entirely excluded in England, as an abuse of the patent laws which required to be remedied. With regard to the question of compulsory licences he felt there was a serious question of fact—namely, whether or not a man had used his patent rights unreasonably—a question which ought to be left to the Courts of Law. Lord Justice Vaughan Williams remarked that such questions as that last referred to were eminently questions for a jury. If they were left to judges alone the inevitable result would be that they would lay down hard-and-fast rules as to the sort of conduct which amounted to the forfeiture of a patent. That, he thought, would be a great misfortune. Other speakers followed.

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

THE gold mining industry of the Transvaal is still in a condition of restricted activity, notwithstanding the fact that the October output showed an increase of 14,715 ounces over the figures for September. On the other hand, things are brisk in the Rhodesian mining centres, and large orders for plant and machinery are being placed. As is usual at this period of the year, serious rumours are being spread concerning the scarcity of water on the Witwatersrand mines. As the closing down of some of the properties is already threatened unless a heavy storm or two come speedily to their relief, this annual difficulty really ought to awake the directors of the mines to the necessity for some endeavour being made to provide an adequate water supply. The existing dams are in many cases mere masonry enclosures of natural surface depressions, and no attempt has been made to give them a proper depth. Naturally the loss from evaporation in such structures is enormous. It should be quite possible for the mining people on the Rand to form a water trust or commission, representing the various companies. Such a body could buy up water rights and construct a huge dam on the watershed to the north of Johannesburg. The cost of pumping would be inconsiderable, and the annual loss of many thousands of pounds would be averted.

The revenue of the Orange Free State Railway for the year ending June 30th was £410,517, or £4839 above the estimates. This should encourage railway extension in the States, the agriculture of which stands pressingly in need of new markets for its produce.

Electric lighting contracts have been given out by the public officials of Kimberley and Laurenço Marques. In both cases the orders for machinery and plant will go to English firms.

The Cape Parliament is discussing the revision of the mail contract. The chief question in dispute is whether the contract should be thrown open to public tender, or be determined by private negotiations with the existing mail lines—the Castle and Union Companies. There is a strong body of opinion amongst the mercantile community that the new subsidy should only be granted upon the condition of the abolition of the shipping "ring," and the rebate system of freights upon which it is established. The Government, however, appears to be strongly opposed to introducing this question of freights into the arrangements of the mail subsidy, and it takes up the position that it ought not to interfere in the bargains made between the steamship companies and their customers. It is proposed, under the new contract, to establish a mail service of fourteen days between Southampton and Cape Town. One shipping company has even made an offer to undertake a twelve-day service, but this would mean an enormous increase in the subsidy. One suggestion made in the course of the debate was that the Cape Government should provide itself with steamers, instead of paying subsidies to private companies.

The sewerage scheme at Cape Town, which has been undertaken at a total cost of £250,000, is making good progress, and 54 miles of sewer have now been laid. The works include the providing of five of Shone's patent ejectors for raising the sewage from the lower levels of the town. The compressed-air plant for these ejectors consists of two horizontal duplicate double-acting engines, with steam cylinders 7in. in diameter, and air cylinders 10in. in diameter by 14in. stroke.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal: The market is quiet, owing to the want of prompt tonnage, the boisterous weather keeping steamers back. House coal: The same remark applies to the house coal shipping. Exports for week ending December 2nd were:—Coal, foreign, 54,125 tons; coastwise, 18,391 tons. Imports for week ending December 1st were:—Pig iron, 1220 tons; iron ore, 5339 tons; pitwood, 2760 loads; steel bars, 252 tons; old iron, 345 tons; three cargoes potatoes; one manure; one cement; 1200 tons phosphates.

Coal: Best steam, 10s. 6d. to 11s.; seconds, 9s. 6d. to 10s.; house coal, best, 13s.; dock screenings, 6s. 9d.; colliery small, 5s. 3d. to 5s. 6d.; smith's coal, 7s. to 7s. 6d. Pig iron: Scotch warrants, 49s.; hematite warrants, 56s. 10d., f.o.b. Cumberland; Middlesbrough, No. 3, no quotation; Middlesbrough hematite, 54s. 9d. Iron ore: Rubio, 14s. to 14s. 3d.; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails, heavy sections, £4 15s. to £4 17s. 6d.; light ditto, £5 to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke 10s. 9d. to 11s.; Siemens—coke finish—11s. to 11s. 3d. Pitwood, scarce. London Exchange Telegram: Copper, £55 3s. 9d.; Straits tin, £82 5s. Freights: Freights remain firm, both foreign and coasting.

LAUNCH. — Turkistan; steel screw steamer, spar-deck type; built by, Messrs. W. Gray and Co., Limited; to the order of, Messrs. Frank C. Strick and Co., Limited; dimensions, 362ft. by 45ft. by 26ft. 8in.; engines, triple-expansion, 28in., 43½in., and 72in. by 48in.; constructed by Central Marine Engine Works; trial trip, December 5th; 15 knots.

TRADE AND BUSINESS ANNOUNCEMENTS.—Consequent upon the appointment of Mr. W. H. Radford to the position of bridgemaster for the county of Lancaster, the business of Messrs. William Radford and Son, Brazenose-street, Manchester, has been transferred to Mr. Joseph Swarbrick, of Temple-chambers, Manchester.—Messrs. Uhlmann and Keutgen have secured larger premises at No. 207, Pentonville-road, N.—Messrs. L. Gardner and Sons have removed to new works at Barton Hall Engine Works, Patricroft, Manchester.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

**** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

24th November, 1898.

24,840. GENERATION of MOTIVE POWER, V. Tournier and the New Motive Power Syndicate, Limited, London.
24,841. SECURING ENDS of CORDS, O Imray.—(*W. W. Cabena, Victoria.*)
24,842. DISPLAYING STEREOSCOPIC TRANSPARENCIES, J. Rose, London.
24,843. CONNECTING DYNAMOS to SWITCHBOARDS, W. C. P. Tapper, London.
24,844. TANNING, J. V. Koch, London.
24,845. ROTARY EXPLOSION MOTORS, J. B. M. A. Coard and E. A. Charpentier, London.
24,846. APPARATUS for CARBURETTING GAS, W. Irwin, Manchester.
24,847. COATS, A. M. Burberry, London.
24,848. TREATING DECAYED RUBBER, M. Zingler, London.
24,849. BURIAL CASKETS, W. H. Moore, London.
24,850. BRACKETS, E. J. Matthews, London.
24,851. ROTARY MOTOR, L. Defiesselle, London.
24,852. WATER-TUBE BOILER, J. Mazières, London.
24,853. THREAD TENSION DEVICE for SEWING MACHINES, H. H. Lake.—(*J. E. Bertrand, United States.*)
24,854. BOOT FASTENINGS, F. J. Stohwasser and G. B. Winter, London.
24,855. ELECTRIC SIGNALLING APPARATUS, A. U. Alcock, London.
24,856. MOTOR CAR FRAMES, T. Myers, London.
24,857. CHANGING PHOTOGRAPHIC FILMS, A. L. Adams, London.
24,858. BUROLAR ALARMS, B. J. P. Roberts, London.
24,859. ELECTRIC SPARKING PLUGS, F. R. Simms, London.

25th November, 1898.

24,860. SCAB WASH, A. Robertson, London.
24,861. GUARDS for CIRCULAR SAWS, W. A. Webster, Manchester.
24,862. GENERATING ACETYLENE GAS, A. Dickson and H. Wallace, Glasgow.
24,863. SPEED INDICATORS for VEHICLES, J. Grosart, Glasgow.
24,864. BED-POST ATTACHMENT, C. J. Bigger, Bristol.
24,865. SWIVEL LOOMS, E. Hollingworth.—(*G. F. Hutchins, United States.*)
24,866. MACHINE for BORING OVAL HOLES, C. Janssen, Birmingham.
24,867. ROTARY STEAM ENGINES, D. Morell, Manchester.
24,868. CONNECTING MATTRESSES to BEDSTEADS, L. Johnston, Walmley, Warwickshire.
24,869 COPPER FURNACES, W. Kerridge, Ipswich.
24,870 HORSESHOES, J Kemp, Eastbourne.
24,871. FIREMAN'S HEADGEAR, R. McBurnie and J. Mason, Manchester.
24,872. ELECTRIC DYNAMOS and MOTORS, J. Atkinson, Marple, Cheshire.
24,873. JAM-BOILING PANS, W. Brierley, Rochdale
24,874. CONFECTIONERY CUTTING MACHINES, W. Brierley, Rochdale
24,875 CRICKET BAT HANDLE, B Warsop, London.
24,876. INCREASING the POWER of DRIVING GEAR, J. McKane, Belfast
24,877 TEA INFUSER, W. H Ratcliffe, Derby.
24,878 ALLOY of ALUMINIUM and MAGNESIUM, A. G. Brookes.—(*L Mack, Germany*)
24,879. PANELS for BASSINETTES, J. Harrop, Manchester.
24,880. SHIPS' RUDDERS, W. R. Lawson, London.
24,881. DEVICE for WINDOW CLEANING, J. Webster, Exmouth, Devon.
24,882. SCISSORS H. Cheesman, Newcastle-on-Tyne.
24,883. SPEED GEARS for VEHICLES, C. H. Shacklock, London.
24,884. FOLDING SHAFTS of MAIL-CARTS, J. Carr, Bradford.
24,885. GAS GENERATORS, W. Riley and A. Kershaw, Bradford.
24,886. FIRE-LIGHTERS, A. J. Roberton, Manchester.
24,887. ALARM CLOCK, T. Millar, Glasgow.
24,888. BICYCLE, J. Cochran and C. Watkin, Armagh.
24,889. RIVETING APPARATUS, J. MacE. Ross, Glasgow
24,890. VALVES, J. Chalmers, Glasgow.
24,891. RETORTS for DISTILLING SHALE, W. Young and J. Fyfe, Glasgow.
24,892. LOCKING INDICATING DECK-PLATE, T. White, Glasgow.
24,893. GUIDE-BARS for AXLE-BOXES, D. J. Morgan, Barry, Glam.
24,894. WINDOW WASHER, R. H. Dunn, Street (S. O.), Somerset.
24,895. SEALING the MOUTHS of BOTTLES, R. G. Nash, London.
24,896. WATER-TUBE BOILERS, G. N. Philip, London.
24,897. SUPERPOSED CARDERS, P. Bastin, London.
24,898. POCKET STANDS for CAMERAS, R. de Columbier, London.
24,899. AUTOMATIC LIFE-SAVING RAFT, R. de Columbier, London.
24,900. HARNESS, V. P. Berrurier, London.
24,901. COAL-WASHING APPARATUS, H. St. J. Durnford, London.
24,902. HOISTS, S. Bündel and C. Klinik, Birmingham.
24,903. APPARATUS for TANNING SKINS, T. H. L. Bake, London.
24,904. STRAINING PAPER PULP, W. W. Beaumont, London.
24,905. PREPARING HYDROCYANIC ACID, R. Bayer, London.
24,906 NITRO-SUBSTITUTION under PRESSURE, C. Schneider, London.
24,907. SHIPS, F. G. Sennett and W. G. Williams, London.
24,908. ATTACHING GAS BRACKETS, &c., J. Lewis, London.
24,909. MAKING CALCIUM CARBIDE, H. Walker, London.
24,910. DOORS for GAS FURNACES, B. A. Burrell, London.
24,911. CURVED TYPE, R. J. Day and A. Collins, London.
24,912. ELECTRIC FITTINGS, C. S. Bradford, Kingston-on-Thames.
24,913. CONNECTING-RODS, J. T. Norris, Kingston-on-Thames.
24,914. ELECTRIC HINGES, F. E. Chandler, Kingston-on-Thames.
24,915. SHAVING the SURFACE of SKINS, E. E. Pullman, London.
24,916. INDICATOR for COOKERY RECEIPTS, E. Howe, London.
24,917. TEACHING PERSONS to CYCLE, W. J. Blaxton, London.
24,918. MATCH BOX HOLDER for CYCLES, J. J. Snow, London.
24,919. CLOSING SHUTTERS, &c., J. H. Dierickxx, London.
24,920. BALING PRESSES, H. H. Lake.—(*C. L. Hovden, Norway.*)
24,921. FACILITATING DRAWING from MODELS, H. Sheaf, London.
24,922. SUSPENDING PAPER BAGS, &c., A. McCabe, London.
24,923. OIL LAMPS, H. Lane, London.
24,924. BOOT LACES, E. H. Ludlow and A. Whittall, London.
24,925. CYCLE HUBS and BEARINGS, W. Woodhead, London.
24,926. HINGES, A. J. Boult.—(*G. Weber, Germany.*)
24,927. PENCIL-SHARPENING MACHINES, R. M. Jones, London.
24,928. BRICK-MAKING MACHINES, G. Austin, London.
24,929. COMBUSTION of LIQUID HYDROCARBONS, O. Meurer, London.
24,930. AIR-TIGHT COVERS for VESSELS, A. Schmalenbach, London.
24,931. BURNING LIQUID HYDROCARBON, F. R. Blount, Liverpool.
24,932. COMPOSITION for PAINTING, A. Nevin and T. Bulfield, Liverpool.
24,933. SULPHURIC ANHYDRIDE, W. P. Thompson.—(*G. Wachin, Russia.*)
24,934. PACKING for SCREW TAPS, T. Garner, Manchester.
24,935. WATERPROOFING FABRICS, G. T. Oliver and W. Derby. Manchester.
24,936. SOLDERING IRON, G. P. W. Richards, London
24,937. TRACTION ENGINES, W. Foggo, London.
24,938. PREVENTING WINDOWS being OBSCURED by MOISTURE, L. Pinner and W. Ornstein, London.
24,939. CLOSETS, C. H. Martini, London.
24,940. UNLOCKING EMERGENCY EXIT DOORS, T. E. Hewitt, London.
24,941. DRYING BRICKS O. Howl, London.
24,942. CYCLE SIGNAL BELLS, J. H. Thieme and O. O. Alt, London.
24,943. NEEDLE-CASE, K. F. Koch and G. Schmiedeken, London.
24,944. LOCKING the WHEELS of VEHICLES, H. S. T. Wildman, London.
24,945. BALL BEARINGS, G. E. Mittinger, jun., and F J. Schweitzer, London.
24,946. OPTICAL PROJECTION APPARATUS, J. G. Lorrain.—(*H. O. Foersterling, Germany.*)
24,947. BICYCLES, T. G. Palmenos, London.
24,948. AMMUNITION HOISTS for SHIPS, A. T. Dawson, T. Thackeray, and J. Horne, London.
24,949. REGULATING TRANSFORMER for ELECTRIC INSTALLATIONS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
24,950. PIVOTS for SWINGING WINDOW SASHES, W. Nicholson, London.
24,951. GEAR for COMMUNICATING POWER, C. L. Kline and C. L. Kline, jun., London.
24,952. CARRYING BICYCLES, H. L. Webster, London.
24,953. GENERATORS for ACETYLENE GAS, L Morris, London.
24,954. INCANDESCENT GAS LIGHTING, W. B. Smith, London.
24,955. UTENSILS for SHAVING-WATER, F. R. Begbie, London.

26th November, 1898.

24,956. ANTI-VIBRATOR for OIL LAMPS, R. H. Smith, London.
24,957. PIPES, J. R. W. Woodward and N. Collier, Derby.
24,958. UNDERCLOTHING, W. H. Stevens, Leicester.
24,959. AUTOMATIC BRAKE, T. H. and E. Mitchell, Manchester.
24,960. ENGINE BEARINGS, T. H. and E. Mitchell, Manchester.
24,961. TRAVELLERS' SAMPLE CASES, T. A. Sands, Birmingham.
24,962. STEERING FLYING MACHINES, J. Vreugdenhill, London.
24,963. CORSETS, H. A. R. Champness and R. H. Mitchell, Manchester.
24,964. STOPPER ATTACHMENT, J. Bourey, Bristol.
24,965. ELECTRICAL INSTRUMENT, G. T. Hanchett and F. B. Sage, Manchester.
24,966. WHEELS, R. W. Macculloch and F. Gash, West Kirby, Cheshire.
24,967. PISTONS, J. G. A. Kitchen, Manchester.
24,968. BEARING, S. Walker and W. Morris, Radcliffe, Lancs.
24,969. METHOD of FASTENING SHOES, T. Sargent, Bristol.
24,970. STARTING GAS and OIL MOTORS, S. Griffin, Bath.
24,971. DRESS FABRICS, H. B. Priestman and S. H. Rawnsley, Bradford.
24,972. CYCLE BRAKE, T. Adamson and F. W. Barlow, Bolton.
24,973. GRINDSTONE TOOL TIPPING REST, A. Thackwray, Leeds.
24,974. RACKS for SCREW-CUTTING TOOLS, J. T. Dunstan, Bristol.
24,975. GENERATORS for ACETYLENE, E. L. Levetus, Leeds.
24,976. EXPANDING CORSET, R. Fairhurst, Wigan, Lancs.
24,977. CYCLE FRAMES, W. Andrew, Manchester.
24,978. CRYSTALLISING SODIUM CARBONATE, J. Dekker, Glasgow.
24,979. TIRES, R. Mitchell, jun., and J. Mitchell, Glasgow.
24,980. COG-WHEEL BRAKE for BICYCLES, J. Tiffen, Carlisle.
24,981. SCENT BOTTLE and FAN, J. C. B. Townsend, London.
24,982. OVERHEAD ELECTRIC TRACTION, W. R. Smith, London.
24,983. SOFTENING WATER for ENGINES, E. J. Davis, London.
24,984 OIL RESERVOIRS for LUBRICATORS, E. J. Davis, London.
24,985. CHAIN ADJUSTERS for CYCLES, F. G. Griffith, London.
24,986. CONNECTING ENDS of BANDS, J. McKechnie, London.
24,987. SOCKETS for CARRIAGE LAMPS, W. J. Copestone, London.
24,988. INCANDESCENT MANTLE FOUNDATION, R. M. Shelley, London.
24,989. VEHICLE for COMMON ROADS, F. W. Giller, London.
24,990. DEVICE for FILLING PNEUMATIC TIRES, B. Cahn, London.
24,991. SHIPS, R. Wesch, London.
24,992. AUTOMATIC TELEGRAPH APPARATUS, G. Giorgi, London.
24,993. PISTONS, C. Lockwood, London.
24,994 OPTICAL APPLIANCE for FINDING VIEWS, W. Mallett, W. Watson, C. W. Beevor, and A. L. Adams, London.
24,995. BURNERS, E. E. Crook and M. A. Hunting, London.
24,996. PERAMBULATORS, &c., F. J. McKenzie, London.
24,997. TWISTING THREAD, M. Beaumann and A. Kryszat, London.
24,998. WASHING LINEN, F. Moll and M. P. O. Dickhuth, London.
24,999. FOLDING DESKS and SEATS, S. Akbroit, London.
25,000. PURIFYING SEWAGE, W. P. Thompson.—(*C. G. Gaell, Germany.*)
25,001. SIDE SCUTTLES for SHIPS, W. Mullan, Liverpool.
25,002. PRESSES for BALING COTTON, J. Conder, Liverpool.
25,003. BRUSH, G. Stiehle, Liverpool.
25,004. BRAKES for VELOCIPEDES, A. C. Shergold, London.
25,005. INSTRUMENTS for DRAUGHTSMEN, A. J. Boult.—(*H. Herbery, Germany.*)
25,006. INTERNAL COMBUSTION ENGINES, J. B. Lafond, London.
25,007. MIXING and KNEADING MACHINE, P. Küpper, London.
25,008. PREVENTING SHIPS from SINKING, A. E. Broquet, London.
25,009. LAMP, C. Vernier, London.
25,010. EXHAUSTER for CORROSIVE GASES, J. Müller, London.
25,011. HAT PINS, O. Cholerius and A. Herrmann, London.
25,012. STEAM ENGINES, B. Gee and R. Webster, London.
25,013. ELECTRIC ARC LIGHTING, A. Vosmaer, London.
25,014. AUTOMATIC LIGHTING of GAS MANTLES, L. Moris, London.
25,015. TREATING RESIDUE from PLATINUM, L. Moris, London.
25,016. ACETYLENE GAS GENERATORS, A. Schwass, London.
25,017. DYEING HAIR and FURS, C. D. Abel.—(*The Action-Gesellschaft für Anilin Fabrikation, Germany.*)
25,018. TREATING VEGETABLE FIBRES, F. Hasselmann, London.
25,019. VEHICLES, C. E. Sibley and R. Bryan-Haymes, London.
25,020. TREATING BICHROMATE of SODA, A. Goldschmidt, London.
25,021. SECURING the BASIS of BOXES, J. W. Claughton, London.
25,022. CYCLE SADDLE, W. E. Carmont and H. de Stedinhk, London.
25,023. TRAMWAY CARS, O. Brennecke and I. Timar, London.
25,024. CARDBOARD BOX, F. T. Austin, London.
25,025. TEETHING APPLIANCE, A. J. Tempère, London.
25,026. METAL SUPPORT for COUNTERDIKE, R. J. Copas, London.
25,027. MANUFACTURE of BARYTA, H. H. Lake.—(*La Société Bonnet, Ramel, Savigny Giraud et Marnas, France.*)
25,028. TIRE, E. Kempshall, London.

28th November, 1898.

25,029. MEASURING the EFFICIENCY of GEARING, A. Sharp, London.
25,030. CARBURETTING, C. Bingham, London.
25,031. CULTIVATORS, W. E. Martin, Huntingdon.
25,032. COVERINGS for BABY CARRIAGES, G. A. Barnard, Winchester.
25,033. GEARING for VELOCIPEDES, H. J. Bagley London.
25,034. SOAP, S. V. Dardier, London.
25,035. CONTROLLING RAILWAY PLATFORM TROLLEYS, A. B. Payne, Sketty, near Swansea.
25,036. CARDBOARD BOXES, A. W. Stevenson and G. Donaldson, Manchester.
25,037. LOCKING the DOORS of TRAINS, J. Marshall, Glasgow.
25,038. DIVIDING CIRCLES into PARTS, R. C. Craig, Glasgow.
25,039. SHUTTLE OPERATING MECHANISM for LOOMS, L. Cheesebrough, Keighley.
25,040. RAILWAY PLATFORM TRUCKS, G. P. Edwards, Wolverhampton.
25,041. FIXING LIDS to BOXES, J. Mowat and J. Watt, Helensburgh.
25,042. COMPASS CARD, E. Gruby, Hull.
25,043. PHOTOGRAPHIC PRINTING, A F. Hargreaves, Midlothian.
25,044. MECHANISM for COIN-FREED GAS METERS, J. Milne and H. O'Connor, Edinburgh.
25,045. MECHANICAL TOY, A. W. Pocock, London.
25,046. HEATING KILNS or OVENS, J. T. Cope, Birmingham.
25,047. MACHINERY for CRUSHING ORE, R. A. White, London.
25,048. SADDLES for HORSES, T. B. Sharp and G. Miner, Birmingham.
25,049 BACK-PEDALLING BRAKES for VELOCIPEDES, R. Riddle, Birmingham.
25,050. SOWING ARTIFICIAL MANURES, R. and W. Wallace, Glasgow.
25,051. ELECTRIC ALARMS, C. A. Gillespie, Glasgow.
25,052 CYCLE SELF-LOCKING APPARATUS, F. L. Jeyes, London.
25,053. WASHERS for PIPE FLANGES, C. H. Jolliffe and H. H. Deacon, London
25,054. SILK-HOLDING DEVICES, C. A. Allison.—(*S. Sweeney, United States*)
25,055. SOUNDING APPARATUS, J. O'Neil, London.
25,056. WOVEN STUFFS with SILK IMITATIONS, H. Edelhoff, Germany.
25,057. EXCENTRIC SWIVELLING CHAIRS for SHIPS, A. Robertson and J. Rowan, Glasgow.
25,058. AUTOMATIC FUSE REPLACER, H. G. Solomon, London.
25,059. TORPEDO GUN, J. O'Kelly, M.P., London.
25,060. DRAG for VESSELS, M. D. Cvetkovich, G. Kukac, C. Mingotti, and A. Sirola, Glasgow.
25,061. PORTABLE BALANCE THERMO-REGULATOR, R. H. Cox, Shanghai, China.
25,062. THE "COMPREHENSIVE" CALENDAR RULE, G. Stevenson, Accrington.
25,063. HOT-WATER HEATERS, A. J. Boult.—(*W. J. Walsh, G. M. Ryckman, and M. H. Le Hane, Canada.*)
25,064. WEIGHING MACHINES, J. Joynson, London.
25,065. MATCH-BOXES, &c., for HOTELS, J. A. Firth, London.
25,066. FIRE EXTINGUISHER, J. W. Naylor and W. Harrison, London.
25,067. COIN-FREED MECHANISM, C. F. Stahlecker, London.
25,068. CONDENSERS and EVAPORATORS, S. Puplett, London.
25,069. SEATS for WATER-CLOSETS, A. L. Trotman, London.
25,070. TOOTH-BRUSHES, A. Worringen, London.
25,071. SADDLE SEAT, W. F. Hole.—(*J. I. Knight, New Zealand.*)
25,072. AUTOMATIC COIN REGISTER, The Globe Cashier, Limited, and W. D. Rowlingson, London.
25,073. SOUP POWDER, A. W. Turner and J. Tibbitts, Birmingham.
25,074. RACKS for CYCLES, T. Hewitt, London.
25,075. REFLECTORS for LAMPS, G. Huebner.—(*A. Müller, Austria-Hungary.*)
25,076. DISPLAYING PICTURES, A. R. Upward and R. Dalmer, London.
25,077. CHANGING SURFACES for ADVERTISEMENTS, A. R. Upward and R. Dalmer, London.
25,078. MACHINE CUTTER HOLDER, M. L Tucker and Disc and Easy Churns, Limited, Chesham.
25,079. BURNERS for HEATING and LIGHTING, M. Crawford, London.
25,080. RAILWAY SIGNALS, C. Brawn, London.
25,081. REVOLVING DOORS, T. V. Kannel, London.
25,082. BAND for HOLDING TOGETHER the RIB ENDS of UMBRELLAS, G. Kurschner, London.
25,083. WALL ATTACHMENT for HOLDING BICYCLES, A. F. Smith and W. Mays, London.
25,084. PHONOGRAPHS, L. Wolff, Liverpool.
25,085. FLUSHING CISTERN for WATER-CLOSETS, J. W. T. Brain, Birmingham.
25,086. SYPHON-HEAD DEVICE, R. Ebersbach and G. Rakovan, London.
25,087. ARC LAMPS, W. Crudgington, Birmingham.
25,088. SHIP LOG APPARATUS, T. F. and T. S. Walker, London.
25,089. BREAD KNIFE with a GAUGE, H. Eisenmann, London.
25,090. LOOMS for WEAVING PILE FABRICS, A. Webb, London.
25,091. FLEXIBLE STAYS for AIR CUSHIONS, A. A. Young, London.
25,092. ROTARY PRESSURE ENGINE, S. A. E. Hickson, London.
25,093. SWING GATES, J. H. Hannay, London.
25,094. SEALING CASK VENTS, R. Haddan.—(*J. D. y Farris, Spain.*)
25,095. CONDUCTOR for SUBMARINE CABLES, G. G. M. Hardingham.—(*The Firm of Felten and Guilleaume, Germany.*)
25,096. REMOVING DUST from CHAFF, A. S. F. Robinson, London.
25,097. ALLOYS of COPPER, W. L. Wise.—(*J. Burns, United States.*)
25,098. ELECTRIC TRAMWAYS, S. P. Thompson, Liverpool.
25,099. GRIPPING DEVICE for MINE CAGES, P. G. Kelly, London.
25,100. ADVERTISING BAGS for GOODS, E. de Vernoys, London.
25,101. TREATING YEAST, R. Rückforth, London.
25,102. IGNITION MATERIAL for MATCHES, R. E. A. Gans, London.

25,103. STIFFENERS for SHIRT FRONTS, R. Williams, London.
25,104. FOLDING BOXES, A. S. King, London.
25,105. SALT CELLARS, H. Binley, London.
25,106. ROCK-BORING APPARATUS, F. Baker, London.
25,107. MACHINERY for PRODUCING CARDBOARD BOXES, S. Cropper.—(*Partly by T. L. Cornell, United States.*)
25,108. APPARATUS for TAKING PHOTOGRAPHS, E. J. Ball, Plymouth.
25,109. ELECTRIC HOISTING MACHINERY, J. W. Brown and A. J. G. Simpson, London.

29th November, 1898.

25,110. BIFOCAL SPECTACLE LENSES, W. E. Debenham, London.
25,111. DRIVING GEAR for VELOCIPEDES, G. Brown, Plumstead, Kent.
25,112. HORSESHOES, J. G. Hunt and F. C. Boden, Southampton.
25,113. PNEUMATIC HAMMERS, D. Longworth, Banbury, Oxon.
25,114. DIVISIBLE HANDLE-BAR, K. E. Norie, London.
25,115. MODEL PRESSER, W. Robinson, Luton.
25,116. NON-SLIPPER, E. de V. Buckingham, Gainsborough, Lincolnshire.
25,117. TOOL HOLDER, S. J. Spurling, Plumstead, Kent.
25,118. TREATING COKE OVEN GASES, B. H. Thwaite, London.
25,119. HARNESSES for WEAVING, W., D., and J. T. Hardaker, Bradford.
25,120. FOLDING CHAIRS, O. L. Story, Kingston-on-Thames.
25,121. PRUNING IMPLEMENTS, A. H. Knight, Kingston-on-Thames.
25,122. SEAMLESS TUBES, B. F. McTear and W. Lindsay, Liverpool.
25,123. WEATHER PROTECTORS for CYCLISTS, R. Slack, Manchester.
25,124. LAMPS, A. W. Turner and J. Adie, Birmingham.
25,125. ADJUSTABLE GRIPPING DEVICE, B. Smith, Bristol.
25,126. CHURNS, S. C. Jones, Sheffield.
25,127. GONG ALARM, W. Baily, Malvern Wells.
25,128. HEATING WATER by STEAM, L. Marshall and S. Naylor, Halifax.
25,129. BEDSTEADS, J. E. Hoskins and G. R. Payne, Birmingham.
25,130. IRONING MACHINES, J. McAllister, Glasgow.
25,131. EMERY ROLLERS, J. G. Bamforth, Huddersfield.
25,132. DRIVING MECHANISM for BICYCLES, W. E. Taft, London.
25,133. ALBUMS, O. Firth, Bradford.
25,134. SCHOOL DESKS, F. H. Fisher, Birmingham.
25,135. WALKING STICKS, E. Clarkson, Bradford.
25,136. ENVELOPES, S. Bearder, Bradford.
25,137. ADVERTISING, C. W. Hollis, Nottingham.
25,138. METALLIC PACKINGS, J. G. A. Kitchen, Manchester.
25,139. PRODUCING GASES, J. M.-L. Messerli, Leicester.
25,140. EDUCATIONAL GAME, E. Hagen, Manchester.
25,141. APPLIANCES for KEEPING the MOUTH CLOSED DURING SLEEP, H. L. S. Cocks, Bristol.
25,142. ATTACHING INDIA-RUBBER SOLES to BOOTS, P. M. Matthew and J. M. Chalmers, Leith.
25,143. BICYCLES, G. Caddick, London.
25,144. ROAD VEHICLES, J. Chilow and H. E. Orton, London.
25,145. MAIL-CARTS for CHILDREN, H. Thomsett, London.
25,146. TIRES, J. F. Child and W. O. Collingwood, London.
25,147. RECEPTACLES for HOLDING CIGARS, A. Kyd, Glasgow.
25,148. CUTTING WEFT VELVET, A. Eppinger, Manchester.
25,149. NON-INTOXICATING DRINKS, J. H. Brodrick, Birmingham.
25,150. PNEUMATIC TIRES for CYCLES, J. Robinson, Ipswich.
25,151. PROJECTILES, &c., G. Roth and C. Krnka, Glasgow.
25,152. WIRE HEALDS for WEAVING, B. Lee, Colne, Lancs.
25,153. COOKING UTENSIL, G. MacMurdie, G. Wright, and J. H. Borrett, London.
25,154. SPRING SADDLE for CYCLES, A. Woodmansey, London.
25,155. ARTIFICIAL MARBLE, T. W. James, Birmingham.
25,156. APPLIANCE for TEACHING SWIMMING, J. Wilson and W. Walker, London.
25,157. CYLINDER PUMPS, A. Rigg and J. C. Bayley, London.
25,158. RECOVERING SULPHURIC ACID from GASES, T. R. Shillito. — (*The Actiengesellschaft für Zink-Industrie vormals W. Grillo and M. Schroder Germany.*)
25,159. BLIND-ROLLERS, F. W. Phillips and E. Nash, London.
25,160. PRODUCTION of ACETYLENE GAS, C. Barnett, London.
25,161. CYCLE LOCK, F. M. Boclet and A. Turner, London.
25,162. LOCKS, A. H. Walker.—(*The Universal Lock Company, United States.*)
25,163. LOCKING COCKS, J. and T. H. Nodder, Sheffield.
25,164. RECEPTACLES for PACKING FRUIT, J. H. Arkwright, London.
25,165. BURNING GAS, C. G. Hemsley and P. S. Squirrell, London.
25,166. LOCKING CARRIAGE DOORS, C. E. Cooper, London.
25,167. COMBINATION FURNITURE, J. Brustmann, London.
25,168. CUTTING-OFF VALVES, A. Langhammer, London.
25,169. BEDSTEADS, A. Strohlberg, London.
25,170. CHIMNEY SHAFT, A. Geiger, London.
25,171. ASBESTOS, L. Grote London.
25,172. JOINING RAILWAY SIGNAL RODS, T. S. Lewis, London.
25,173. IRON and STEEL CHAINS or LINKS, W. Roberts, London.
25,174. ENGINE, T. King, London.
25,175. CHOPPING FIREWOOD, J. Robbins and H. C. Burton, London.
25,176. GUN MECHANISM, A. Reichwald.—(*F. Krupp, Germany.*)
25,177. GUN MECHANISM, A. Reichwald.—(*F. Krupp, Germany.*)
25,178 TENSION-CONTROLLING DEVICES, S. H. Wheeler, London.
25,179. BALL BEARINGS, C. H. Ferguson, London.
25,180. ARITHMETICAL CALCULATORS, W. A. Drake, London.
25,181. HORSESHOES, T. Allwood and V. A. Bailey, London.
25,182. POST-MARKING MACHINES, H. H. Lake.—(*E. R. Malmborg, United States.*)
25,183. SIRENS, W. T. Purchase, London.
25,184. DRIVING CHAINS, R. Abell, London.
25,185. CLAPPERS for BELL BUOYS, W. T. Elliott, London.
25,186. FASTENING BICYCLE TIRES, J. McAlpine, Leytonstone, Essex.
25,187. WATER VAN and SWEEPING MACHINE, F. J. Wakeling, London.
25,188. TANNING, A. E. Vidal, London.
25,189. VENTILATING TAP, J. Charman, Crawley, Sussex.
25,190. BICYCLES, L. B. Gaylor, London.
25,191. CAMERAS, H. Hill, E. G. Price, and Photo, Ltd., London.
25,192. FLEXIBLE TUBE JOINERS, W. Puzey, London.
25,193. MACHINES for CUTTING STIFFENERS for BOOTS, H. H. Lake.—(*W. F. O'Brien and D. S. Keith, United States.*)
25,194. PREVENTING OVERTURNING of FLOWER POTS, J. E. Austin, London.
25,195. SMOKE CONSUMERS, J. McDonald, W. H. Klock, and C. A. Hall, London.
25,196. SHOES for HOOFED ANIMALS, W. H. Wakfer, London.
25,197. SCREW NUTS, O. Imray.—(*W. H. Carruthers, United States.*)
25,198. PACKING RABBITS, J. B. Zander and J. Cooke, London.
25,199. BURNER, A. Rammoser, E. Röhrs, and H. Röhrson, London.
25,200. HOLDERS for BILLIARD CHALK, R. W. Hodges, London.
25,201. UTILISING HEAT, R. Haddan.—(*J. E. Whiting, India*)
25,202. ELECTRIC ALARM CLOCKS, L. Schott, London.
25,203. CLOSETS, J. Duckett and Son, Limited, and J. Duckett, Burnley.
25,204. STEAM-GENERATING APPARATUS, G. C. Fricker, London.
25,205. RADIOGRAPHIC APPARATUS, J. Wertheimer, London.
25,206. NECK WEAR, E. A. Roskilly, London.
25,207. TUBES for VACCINE LYMPH, J. H. Montague, London.
25,208. BOOTS and SHOES, H. Brown and G. Hall, London.
25,209. PRODUCING GAS, E. Pilous, G. Ottermann, and E. Nauheim, Liverpool.
25,210. APPARATUS for NECKING VIALS, J. B. Conde, Liverpool.
25,211. TUBULAR SECTIONS of GLASS, J. B. Conde, Liverpool.
25,212. PROJECTILES, S. V. Buskirk, London.
25,213. TURNING VESSELS, C. J. I. Ker and R. F. Bolton, London.
25,214. CRUTCHES, R. Schwarting, London.
25,215. MAKING MATCHES, G. C. Marks.—(*F. W. Mead, United States*)
25,216. TRUEING UP EMERY STONES, H. Laucks, London.
25,217. PRODUCING ELECTRIC CURRENTS, R. Echtermeyer, London.
25,218. GULLY GRATINGS, F. G. S. Ham, W. E. Baker, and C. M. Sansom, London.
25,219. MAKING YARN, J. Y. Johnson.—(*W. H. Drury, United States.*)
25,220. LUBRICATORS, N. Bick, London.
25,221. ARC LAMPS, J. J. Rathbone, London.
25,222. FIRING MECHANISM of GUNS, W. and A. Cashmore, Birmingham.
25,223. EYELET FASTENERS, K. H. Otto, Barmen, Germany.
25,224. STEAM ENGINE, O. E. Graham, Kingston-on-Thames.
25,225. CUTTING TWINE, J. Crandall and O. W. Sherwood, Kingston-on-Thames.

30th November, 1898.

25,226. LOCKING DOORS, W. S. Jervois, Blackrock, Co. Dublin.
25,227. ACETYLENE GAS GENERATORS, D. Thubron, Scarborough.
25,228. SLIPPER for FISHING-GEAR BOARDS, E. Bacon and G. Jackson, Grimsby.
25,229. MACHINES for JIGGING ORE, W. A. Green, Aberystwith.
25,230. RAILWAY TRUCK and TROLLEY, W. F. W. Ellis, London.
25,231. STEAM or AIR ENGINES, J. Gemmell, London.
25,232. PAPER BAGS, J. Ralph, Wolverhampton.
25,233. FURNACES, W. Burgan and B. W. Winder, Sheffield.
25,234. FILTER BEDS for SEWAGE PURIFICATION, W. Foster, Leeds.
25,235. FOLDING CARDBOARD BOXES, E. P. Fenton, Manchester.
25,236. VELOCIPEDE-STEERING HANDELS, E. B. Killen, Manchester.
25,237. TABLES, A. Anderson, Glasgow.
25,238. DRIVING HORSES, T. Dunnachie, Glasgow.
25,239. COMBINED COMMUNICATION SHEET, A. Waters, London.
25,240. CALICO PRINTING, R. McKechnie and A. Hodge, Glasgow.
25,241. WINCHES, T. Downie, Liverpool.
25,242. ENGINE GOVERNORS, J. Davidson and T. R. Hampson, Liverpool.
25,243. ENGINE GOVERNORS, J. Davidson and T. R. Hampson, Liverpool.
25,244. DRIVING BELT, W. H. Hoyle and T. Barker, Bolton.
25,245. PUMP CLIPS for CYCLISTS, S. Greenwood, Liverpool.
25,246. SHIELD for HORSE COLLARS, C. McCallum, Glasgow.
25,247. FIREPLACES, W. H. Sherburn, Belper, Derbyshire.
25,248. RUBBER TIRES for VEHICLES, R. Mitchell, jun., Glasgow.
25,249. SAW GUARDS, W. Stevenson and H. Toogood, Stockton-on-Tees.
25,250. LAMPS, J. Aide, A. W. Turner, and T. Roberts, Birmingham.
25,251. CALCULATING APPLIANCE, J. Massel.—(*A. Massel, Russia.*)
25,252. PUZZLE BRICKS for CHILDREN, E. H. Carlyon, Birmingham.
25,253. HORSESHOES, J. Riley, F. J. Astbury, and I. Fisher, Manchester.
25,254. LIFEBOATS, D. J. Morgan, Barry, Glamorgan.
25,255. CYCLE CRANKS, A. Kerfoot and J. J. Kerr, Cappoquin, Co. Waterford.
25,256. TREATING SAP, E. J. C. Christie and R. Anderson, Glasgow.
25,257. CUTTING LOZENGES, T. and J. Morton, Wishaw, Scotland.
25,258. ACETYLENE GAS GENERATORS, P. Harrison, Birmingham.
25,259. ELECTRICAL REVOLUTION INDICATORS, K. Obst, Liverpool.
25,260. ELECTRICITY METER, A. Nunns, Halifax.
25,261. CAMERAS, H. Hill, E. G. Price, and Photo, Limited, London.
25,262. PNEUMATIC TIRES, C. A. Morrison and H. Bausor, London.
25,263. DISINFECTANT FLUSH TANK, A. T. Handley, Hove, Sussex.
25,264. WINDOW SASHES, H. Callow, London.
25,265. LOCOMOTIVE SIGNAL APPLIANCE, D. Wilson, London.
25,266. WORKING JOINERS' VICES, D. F. Dowey, Middlesbrough.
25,267. CIRCLES, J. C. Fergusson, Vancouver, British Columbia, Canada.
25,268. AUTOMATICALLY-IGNITING MANTLES, A. Rammoser, E. Röhrs, and H. Röhrson, London.
25,269. MONEY-BOX, J. Clarke, London.
25,270. FISH-HOOKS, C. E. O. Coleman and J. B. Wright, Birmingham.
25,271. WATER HEATERS, W. Boby, London.
25,272. MUZZLE, J. Hammond, Reading.
25,273. PUMP, G. Kimber, London.
25,274. WEAVING MATS, K. Walker, London.
25,275. FIRE-PROOF PAINT, A. J. Boult.—(*P. Carré, France.*)
25,276. FIRE EXTINGUISHERS, A. J. Boult.—(*P. Carré, France.*)
25,277. WATER-GAS, A. J. Boult.—(*G. Nicolini, Italy.*)
25,278. AIRING LINEN, R. Rainsford.—(*G. W. and C. A. Hall, United States.*)
25,279. OPENING WINDOWS, R. Rainsford.—(*A. Christianson, United States.*)
25,280. SHOE PROTECTOR, C. Hutcheson, Edinburgh.
25,281. OPENING ENVELOPES, F. H. Walker, London.
25,282. TROUSERS CLIP for CYCLISTS, F. H. Walker, London.
25,283. STEAM ENGINES, J. T. Rossiter, London.
25,284. BOTTLE, G. D. Howard.—(*H. Starck, United States.*)
25,285. EXHIBITING PICTURES, J. Schiele, London.
25,286. OIL COMPOSITION, C. J. Grist, London.
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25,288. RAILWAYS, J. Perry, London.
25,289. ROTARY MOTOR, M. Reisacher, Liverpool.
25,290. WINDING APPARATUS, J. W. Smith, Manchester.
25,291. ACETYLENE GAS APPARATUS, N. A. Aubertin, London.
25,292. PRODUCTION of WATERMARKS, T. A. Goodchild and A. C. T. Bond, London.
25,293. SUPPORTING BICYCLES, F. Green and G. Hunt, London.
25,294. SADDLE-SUPPORTING DEVICES for VELOCIPEDES, T. S. Cadet, London.
25,295. SAFETY LOCKS for VELOCIPEDES, M. Badoni, London.
25,296. SEPARATING MOISTURE from MATERIALS, C. E. Kreiss, London.
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25,301. FURNACE GRATES, V. Spinetto, London.
25,302. SUPPLYING WATER to MOTORS, J. Y. Johnson.—(*A. L. Riker, United States.*)
25,303. METALLIC BEDSTEADS, S. I. Whitfield, Birmingham.
25,304. ARTIFICIAL STONES, R. Haddan.—(*R. Koepp and Co., Germany.*)
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25,306. HAIR WAVERS, W. L. B. Hinde, London.
25,307. ENGINES, J. Brundrit, London.
25,308. TIRES, B. H. Thwaite and S. J. Mowbray, London.
25,309. FURNITURE CASTORS, A. C. D. Seifert, London.
25,310. BUTYROMETER, A. Mercier, London.
25,311. WINDOW FRAMES and SASHES, C. Carduck, London.
25,312. BLACK DYESTUFF MANUFACTURE, C. D. Abel.—(*The Actiengesellschaft für Anilin Fabrikation, Germany.*)
25,313. ROTARY PUMPS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
25,314. TRANSFORMING CURRENTS, C. D. Abel.—(*La Société Anonyme pour la Transmission de la Force par l'Electricité, France.*)
25,315. COLOURED MARKING INK PENCILS, A. Roberts, London.
25,316. SMOKE-CONSUMING STOVE, A. Lacolle, London.
25,317. ACETYLENE GAS GENERATORS, G. Dillberg, London.
25,318. TORPEDO BOAT or EJECTOR, G. C. y Elias, London.
25,319. MAKING INNER PARTS of CIGARS, J. Reuse, London.
25,320. RIM BRAKES for CYCLES, J. R. Trigwell, London.
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25,325. CYCLE-DRIVING GEAR, H. Cablanc and L. Burle, London.

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25,326. GAUGES for SAW FENCES, T. Thornton, Bury.
25,327. ELECTRICAL TERMINAL, L. Ridout, London.
25,328. DOBBIES for WEAVING, G. H. Hodgson, Halifax.
25,329. PENCIL and INK ERASER, F. W. Pickering, Pontypool, Mon.
25,330. MEASURING BREAKING STRAINS, J. Hogarth, Glasgow.
25,331. RING SPINNING FRAMES, T. Holden, Manchester.
25,332. TOASTING FORKS, E. S. Browett, Coventry.
25,333. FURNITURE CASTORS, W. Evans, Manchester.
25,334. DISCS, A. J. Stokes, Glasgow.
25,335. TUBES for HEATING and COOLING HALLS, T. Scotland, Tolcross.
25,336. SAW GUARD, J. C. Barnes and C. Cotton, Derby.
25,337. GEAR for PRODUCING ROTARY MOTION, W. Dick, Glasgow.
25,338. ORNAMENTAL COMB for LADIES' HAIR, A. Donnelly, Glasgow.
25,339. ATMOSPHERIC GAS BURNERS, T. Redman, Bradford.
25,340. TABLE KNIVES, J. R. Hunt, Sheffield.
25,341. METALLIC PACKING for PISTON-RODS, A. Shaw and A. Bland Halifax.
25,342. WATER-WASTE PREVENTERS, G. Hunt, Burnley.
25,343. WORKING BAR IRON by STEAM HAMMER, C. J. McIntyre, Barrow-in-Furness.
25,344. "PICKS," W. J. Edwards and T. Thomas, Treharris, Glam.
25,345. WATER-REGULATING CRANES, J. Murrie, Glasgow.
25,346. LADIES' SKIRTS, J. M. Gower, London.
25,347. CYCLE FORK ENDS, D. K. C. Russell, Edinburgh.
25,348. MECHANISM of LOOMS, J. Ireland, Dundee.
25,349. SWINGING BABIES' COT, A. E. Hartley, Bradford.
25,350. LABEL HOLDER, I. T. Swarts, London.
25,351. STRETCHING TROUSERS, I. T. Swarts, London.
25,352. SAFETY GEAR for COLLIERY CAGES, J. Morgan, London.
25,353. BICYCLES, L. A. Chauvin, London.
25,354. FIRE-GRATES, G. G. Brodie and J. D. Prior, London.
25,355. TRANSOM PLATES for VEHICLES, W. Mills and E. D. Mincher, London.
25,356. APPLYING SKID-PANS for ROAD VEHICLES, W. Mills and E. D. Mincher, London.
25,357. COIN-FREED MACHINES, F. Hutchins, London.
25,358. CONTRIVANCE for TRAWL NETS, G. F. and F. W. Stevens, London.
25,359. FACING WALLS with GLASS, C. Marson, London.
25,360. ARTIFICIAL STONE for BUILDINGS, C. Marson, London.
25,361. SHADE for SHIP'S TELEGRAPH, J. O. Dolman, London.
25,362. DIAPASON PIANOFORTES, W. G. and E. Munt, London.
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25,365. WHEEL BRAKES for GUN CARRIAGES, A. Reichwald.—(*F. Krupp, Germany.*)
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25,367. CLOCKWORK TOYS, J. Cross, London.
25,368. ACETYLENE GENERATOR, C. J. and C. E. Watts, London.
25,369. GAS-LIGHTING INSTALLATIONS, A. J. Boult.—(*L. H. Karger, Germany.*)
25,370. STEAM GENERATOR FURNACES, T. Lowe, London.
25,371. FERMENTING TEA LEAF, W. P. Hurst, London.
25,372. DISPLAYING FABRICS, H. Bennett, London.
25,373. SCRAPING MUD OFF CLOTHES, J. Oppenheimer, London.
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25,375. TOBACCO PIPES, W. Stevens, London.
25,376. WHEELS, R. S. Lovelace, London.
25,377. CONTROLLING MECHANISM for MOTORS, J. H. Hoadley, London.
25,378. PHARMACEUTICAL COMPOUNDS, H. E. Newton.—(*The Farbenfabriken vormals F. Bayer and Co., Germany.*)
25,379. PREVENTING TROLLEYS FALLING from PLATFORMS, E. W. Leos, London.
25,380. CASED METAL, W. P. Thompson.—(*G. Parent, France.*)
25,381. STOVES for BURNING-OFF PAINT, G. Roberts, Liverpool.
25,382. TAPS, G. Roberts, Liverpool.
25,383. TREATMENT of SEWAGE, C. A. Atkinson, Liverpool.
25,384. STEAM DERRICK CRANES, T. Whitaker, Manchester.
25,385. PRINTING MACHINES, G. D. Stewart, Edinburgh.
25,386. CLEANERS for PNEUMATIC TIRES, W. Glasgow, London.
25,387. RAILWAY POINTS, J. Grimme, London.
25,388. GENERATING OZONE, W. Elworthy, London.
25,389. PEGGING MACHINES, E. Duplessis, London.
25,390. PUMPING MACHINERY, W. H. Booth, London.
25,391. TIRES, J. F. and L. Gommeret, London.
25,392. BALL RETAINERS and SEPARATOR, E. F. Creager, London.
25,393. FILE CASES, F. Macey, London.
25,394. WEIGHING SCOOPS, B. McKiernan, London.
25,395. COT, HAMMOCK, and STRETCHER, L. C. Bailey London.
25,396. SCISSORS, N. O. Henault, London.
25,397. CANDLES, W. C. Greig and J. H. Gardner London.
25,398. TRICYCLE, P. Dorigny, London.
25,399. BURNING LIQUID FUEL, C. H. Fisher and F. May, London.
25,400. STOVES, R. Jewhurst, London.
25,401. PRESERVING EGGS, A. M. Clark.—(*F. Dippel, Germany.*)
25,402. HEAT RETAINERS, F. Kahn, London.
25,403. BICYCLE SUPPORTS, F. H. A. Heyer, London.
25,404. MONOAZO DYESTUFFS, S. Pitt.—(*L. Cassella and Co., Germany.*)
25,405. MEASURE for SPIRITS, W. R. Littlefield, Leyton, Essex.
25,406. TYPEWRITING MACHINES, W. R. Fox, London.
25,407. STEAM ENGINES, F. J. Thompson and W. Eckford, London.
25,408. HIGH-SPEED ENGINES, J. M. McLean and A. Sykes, London.
25,409. TREATMENT of SEWAGE, C. A. Sahlström, London.
25,410. OZONE-PRODUCING BATTERIES, C. A. Sahlström, London.
25,411. LOCKING CYCLE SPROCKET WHEELS, F. Monnich, London.
25,412. INDICATING in RAILWAY CARRIAGES the NAMES of STATIONS, M. Keller, London.

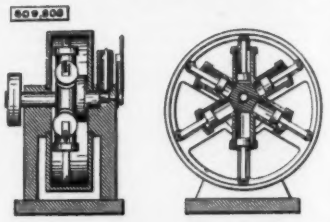
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

609,808. ROTARY STEAM ENGINE, *C. A. Holcomb, Beloit, Wis.—Filed March 18th, 1897.*

Claim.—The combination of a supporting frame having circular projections extending toward each other, a casing having ends supported by the projections, a shaft supported by the frame excentrically to the casing, a series of cylinders rotatable with the

609,808

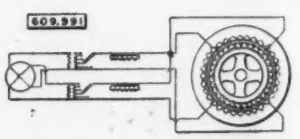


shaft radiating therefrom and located within the casing, each cylinder supporting a piston, and each piston supporting a roller bearing against the inner face of the casing, means for admitting steam to the cylinders and allowing it to exhaust therefrom, the cylinders and casing rotatable together in the same direction.

609,991. METHOD OF AND MEANS FOR SECURING CONSTANT TORQUE IN POLYPHASE MOTORS, *B. G Lamme, Pittsburgh, Pa.—Filed February 10th, 1898.*

Claim.—(1) The combination with an induction alternating-current motor, having a comparatively high-resistance secondary winding and a low degree of magnetic leakage, of a reactive coil in each of the supply circuits, the core of which becomes saturated by a predetermined amount of current, whereby a

609,991



substantially constant torque is secured. (2) The method of producing and maintaining constant torque in alternating-current motors having rotary fields produced by out-of-phase currents, which consists in subjecting such out-of-phase currents to self-induced counter electromotive forces which vary with the current up to a given point, and which vary at a materially different rate beyond that point.

610,302. NOTCH GUN FOR BLAST FURNACES, *J. M. Hartman, Philadelphia, Pa. — Filed May 12th, 1896.*

Claim.—(1) An iron notch gun for blast furnaces, having a tapered nozzle and of sufficient length and size to hold enough plastic material to effectually plug the notch in a single discharge; in combination with means substantially as set forth for admitting fluid pressure into the rear of said gun behind said plastic material and directly in contact therewith without the intervention of any piston, substantially as described. (2) An iron notch gun for blast furnaces,

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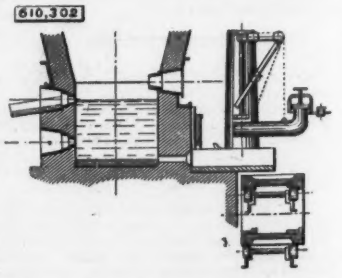


having a tapered nozzle and of sufficient length and size to hold enough plastic material to effectually plug the notch in a single discharge; in combination with means substantially as set forth for admitting fluid pressure into the rear of said gun behind said plastic material and directly in contact therewith without the intervention of any piston; a removable door arranged at the rear end of said gun, substantially a described.

THE JANE NAVAL WAR GAME.

MR. JANE was not the first person to invent a naval kriegspiel, and he will not be the last. But with him lies the honour of first achieving success. Our readers already know something about his game from the various accounts of certain battles that we have from time to time published, but as we have not been, up to the present, in a position to answer the many inquiries we have had as to the manner of playing the game, we shall make no apology for describing in some detail its various parts and the method of simulating naval warfare. In the first place, however, we must remind our readers that the naval kriegspiel is a game only in name. In reality it is a most instructive lesson in the capabilities of different types of ships to withstand or carry on attacks; in the practicability of evolutions and of their usefulness; in the value of gun fire, and of the vulnerability of ships. In short, it puts very fairly before the players the actual problems which would face them were they commanding squadrons in times of war, and if played in seriousness cannot fail to instruct them. The game has, we may, moreover, remind our readers, attracted the attention of many naval officers, and the rules, on which so much depends, have been, we are told, revised and approved by H.I.H. Grand Duke Alexander of the Russian Navy, by Prince Louis of Battenberg, and Captain May, of our own navy, and by Lieutenant Kawashima, of the navy of Japan. We call attention to these facts, because it is as well to make it clear in the first place that time will not be wasted by a consideration of its main points.

The game is played upon as large a table as possible, on which are laid a number of large squares of cardboard ruled into smaller squares of about 1½in. side, the exact size does not greatly matter. The distance between the centres of any two adjacent squares represents 100 yards. On this board, which is the field of operations, scale models of the ships taking part in the action are moved. A model of the Trafalgar, which is before us, is 1½in. long. It is made of cork, and is suitably coloured, the guns and masts being represented by wires. The effect is much better than might be anticipated, but the value of the model lies in the fact that the exact position of the guns is shown, so that in action it is at once evident which of them will bear and on what part of the vessel attacked. As the sides of the squares represent 100 yards, moving a model from one square to the next would be equivalent to a speed of three knots, five squares would equal 15 knots, and so on. Each move is calculated on this one minute basis, and is not supposed to occupy a longer time. In turning, however, speed is lost. Most vessels are allowed to turn 45 degrees on every second square, a few which do not answer well to the helm may only turn once in three, whilst others which are particularly handy may turn 45 degrees in two adjacent squares. The turning of the model through the 45 degrees is held equivalent to one move forward, so that if, for example, it was desired to turn a vessel of 18-knot speed, she would first move straight forward on to the third square from the one she left counting two, then would be rotated 45 degrees counting three, then would make three moves forward to cover the distance equivalent to her speed. All the manœuvring is done in this way, which has proved sufficiently accurate and rapid for all purposes of the game.

With regard to firing and scoring, with every vessel there is supplied a large number of similar drawings of her on thin card. These drawings, elevation and plan, are divided into sections equivalent to 25ft. lengths by vertical lines ¼in. apart, which are numbered consecutively from the bow. The armour is indicated on the *a b c* system, introduced, we believe, by Mr. Jane in his "Fighting Ships." In this system the greatest protection is marked *a a a a*, which is proof against everything except at very close range. Then follow *a a a* equivalent to 30in. of iron, *a a* = 24in. of iron; *a* = 18in.; *b* = 15in.; *c* = 12in.; *d* = 9in.; *e* = 6in.; *f* = thin armour. Guns are indicated in a like manner by capital letters, but all guns over 12in. are called A, and will, with armour-piercing shot, all penetrate *a a* armour at 1000 yards, and the 110-ton gun penetrates *a a a* at the same distance. At 1000 yards, the B guns, anything over 9·2in. and under 12in. calibre, penetrate *a*, at 2000 and 3000 *b*, and at 4000 and 5000 *c* armour. The C D E and F guns penetrate respectively *c d e* and *f* armour at 1000 yards. With armour-piercing shell the value of all guns is less than with shot, and with common shell it is less still, but in each case the area of effect is more. Thus the 12in. gun with armour-piercing shot at 1000 yards goes through *a a* armour, but its area of damage is equivalent to only 1, whilst the area of effect from a 12in. common shell at the same range is 4, but it can only get through *d* armour. The amount of damage done by any shot is marked on pencil on the cards by scribbling over the number of sections destroyed. These sections are formed by the vertical 25ft. lines, and horizontal lines representing the various decks. It is presumed that the damage done is limited upwards and downwards by the decks. A reduced card of the Royal Sovereign after she has been in action—Fig. 1—will make the manner of scoring clearer. The soft bow end, it will be noticed, has been entirely blown away up to the *a a* bulkhead by successive common shell; one of her masts has fallen, and one big gun aft, and two 6in. guns on the port side have been silenced, whilst one D gun in the starboard battery has been put out of action for five minutes by a shell which passed through Section II. on the port side in an oblique direction, and burst among the gun crew.

We give also a reduced target of the same ship. Many of these targets are printed on thin paper for each vessel; they are divided off, it will be observed, in a manner corresponding with the scoring card, and there are different scale drawings for 4000, 3000, and 2000 yards. The firing is done with a striker, consisting of a strip of thin wood about 15in. long, with an enlarged end, somewhere near the centre of which a short pin point projects. The target being laid flat upon the table, one of the views, according to the range and position of the enemy, is struck at; the hole made by the pin point indicates where the shot is supposed to have hit. From a printed card it is then ascertained, knowing the calibre of the gun fired and the nature of the projectile, how many sections are to be marked off on the scoring card. If the projectile strikes armour which it is unable to penetrate, the effect is counted nil. On the same card the rate of fire of the different sorts of guns is also marked. Thus the 12in. gun may fire once in every two complete moves, that is, once in two minutes, whilst all guns under 9·2 may fire once a minute. We understand, however, from Mr. Jane that this rate of fire can with advantage be reduced, as the accuracy of the strikers is too high, and thus actions are, as a rule, over too soon. This manner of firing seems at first sight crude, and it is only after having used it for some time that its suitability is appreciated. In no two strikers is the position of the pin point the same, and the expanded end of the striker is of such size that a large area of the target is covered, so that a sufficiently large margin of chance prevails. It has been found that all the attempts to secure accuracy which different players adopt end, as a rule, in failure, and no matter whether a short stroke or a long stroke is made, the effect is generally the same. As a rule, moreover, the accuracy of firing gets worse as

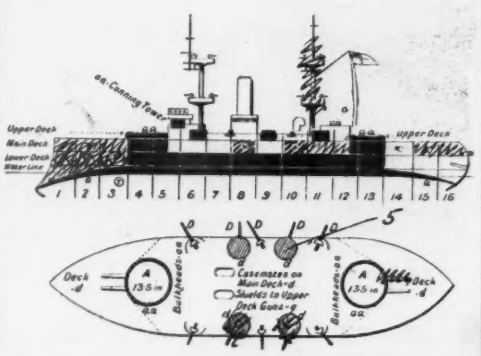


Fig. 1

the excitement increases. It will thus be understood that the strikers do very fairly imitate the conditions of actual shooting, particularly when the rate of firing is reduced according to Mr. Jane's recent suggestion. We need not go further into the manner of playing the game, which will, we hope, be sufficiently well understood from what we have already said. There are, of course, a number of rules on which we have not touched at all, which provide for various conditions, of which it might be advisable on certain occasions to take account; but it is found that for any one action only a few of them are generally required.

It is almost out of the question to review the game critically. At first there are several points which seem as if they would gain by revision; but on a closer acquaintance one begins to see that they have their advantages, and to understand that they have not been made without great consideration and after

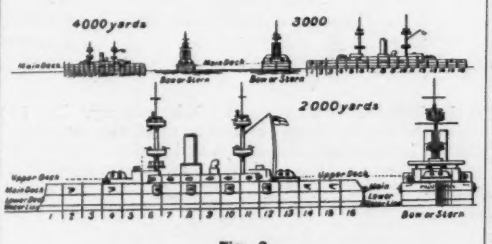


Fig. 2

numerous experiments. For example, it appears at first sight as if the turning rule was defective; but in actual practice it has proved itself suitable for all ordinary purposes, and far simpler than various devices which suggest themselves as improvements. We have already called attention to the strikers, and to the regulations for the number of shots fired per minute. By reducing the rate of fire for the big guns for all ranges, and by reducing the number of small guns fired as the range increases, the actual conditions of warfare are very well simulated, and actions take about as long as they would presumably in reality, if the crews of the various ships were equally cool and courageous. The estimates of the amount of damage done have been worked out from official statistics, and as they have received the approval of very high authorities on the subject, we may safely conclude that they are not far from correct.

We have only touched upon the tactical game, but strategical problems can be worked out with even more value, although experts alone could hope to wrestle satisfactorily with the mass of rules and regulations which an imitation of a great strategical war must necessarily involve. There can, however, be little question that when played by persons well informed on the various points—as, for example, naval and military officers—and when well umpired, a great deal of useful information would be gained from it.

In conclusion, we must congratulate Mr. Jane and those who have worked with him on what they have done. The rules alone, apart altogether from their bearing on the game, contain a mass of information upon ships of war, their armour and armament, their speeds and handiness, which cannot be found in so compact a form elsewhere, whilst a glance through those which apply particularly to the strategical game will show what a number of things have to be thought of by those who command fleets in time of war. The task Mr. Jane set himself has been no light one, and great praise is due to him in that he has succeeded in grappling successfully with problems which it must have appeared at first could never be satisfactorily solved. We have little doubt the naval war game will ultimately be found at least as useful as—and it is certainly more realistic than—our military kriegspiels.

THE WATER SUPPLY IN PARIS.

THE Municipal Council of Paris has recently appointed a Commission to examine the projects which have been presented for bringing fresh supplies of water to the city, and when the final report of this Commission will have been approved of, the Council will vote the necessary credits for carrying out a vast system of water distribution. At present the average daily consumption of water within the city is 550,000 cubic metres, representing 220 litres per head of population. With the exception of Rome, this is the largest consumption of any European capital, and even among the leading cities of the world Paris occupies a fairly high rank in the abundance of its artificial water supply. Notwithstanding the relative completeness of its system of water distribution Paris has often found itself short of water during times of long drought, when it has been necessary to supplement the supplies from the filtering beds and from the sources of the Avre, the Vanne, and the Dhuis, with water drawn direct from the Seine. Not only is it absolutely indispensable to look to further sources in order to provide against such contingencies, but it is evident that the city must be thoroughly equipped with an abundant water distribution by the time of the Exhibition of 1900, and, moreover, the constant increase in the population is a factor that enters seriously into the calculations of engineers. At the present rate of progress, it is estimated that in 1930, the population will be 3,300,000, but in view of the fact that the boundaries cannot extend so long as the present fortifications exist it is not expected that this figure will ever be exceeded. This is the basis taken by engineers in calculating the importance of the system of water distribution to be carried out during the next twenty years.

Of the 550,000 cubic metres of water distributed every day in Paris there are only 253,000 metres available for domestic purposes—that is to say, 203,000 metres of spring water and 50,000 metres of filtered water. This quantity would be quite sufficient at all seasons of the year if it were not for the considerable waste, for which it is not easy to provide a remedy. The Paris engineers do not think that it is possible to devise a means of enforced economy in water consumption, and the only alternative, therefore, is to augment the supplies. It is believed that something may be done in this direction by reducing the loss in the main conduits to a minimum. Seeing that the length of the Vanne conduit is 173 kiloms., the Dhuis 131 kiloms., and the Avre 102 kiloms., it is evident that a good deal of water must be lost during conveyance over such long distances. According to recent estimates the loss from leakages and defects in the conduits amounts to about 25 per cent. in the United States and 30 per cent. in England, and it is certain that in France the loss is no less. It is therefore proposed to increase the grant for the inspection of the conduits, in order that any defects may be promptly made good. By the time the population reaches its maximum—that is to say, in 1930—it will be necessary to augment the supply of pure water by at least 70,000 cubic metres a day. The sources of the Loing and the Lunain will provide from 40,000 to 50,000 metres, and the remainder may be obtained from the filtering basins or by utilising certain other river sources within a convenient radius of the city. The Municipal Council, however, does not propose to confine itself to this limit, but to give an ample margin by providing a daily supply of 400,000 cubic metres of pure water, which will represent 120 litres per head of population. This would be more than sufficient for the domestic needs of the city.

Several projects have already been presented to the Municipal Council for obtaining the additional 160 000 cubic metres necessary to make up this total, and they may be grouped under three heads; that is to say, the utilisation of new springs, the creation of filtering beds, and the bringing of water from the Swiss lakes. This last-named project has been strongly advocated by certain engineers who point out the alleged enormous advantages that would accrue from the conveyance of practically unlimited supplies of water from the Lake of Geneva. It has been estimated that 2,000,000 cubic metres a day would thus be available for Paris. The difficulties of the scheme, however, are so considerable that it has been rejected by all the Commissions which have reported upon it. Even supposing that the Swiss Government would consent to such a mass of water being taken from the Lake of Geneva, the cost of constructing an aqueduct of 500 kiloms. would be no less than £24,000,000, and it would be necessary to re-arrange the entire system of water distribution in the city. Besides this question of cost, it is asked whether any reservoir and conduit could be made strong enough to resist the pressure of such a mass. Since the Bouzey catastrophe, French engineers have begun to exercise more than ordinary caution in dealing with enormous pressures in reservoirs. Again, is it advisable to procure the whole of the water supply from a single source, and thus run the risk of supplies being cut off through an accident to the conduit? A still more powerful argument against the scheme is the poor quality of the water in the Lake of Geneva. Being formed largely of melted snow the water contains very little salts and mineral constituents, and in any event is not so pure as spring water.

This great project having been definitely set aside, the municipal engineers are discussing the various other means of augmenting the water supply. At first it was proposed to make the best of the existing supplies by building an immense reservoir to receive the surplus during the greater part of the year, when the quantity available exceeds the consumption, and thus have an ample reserve during the months of comparative drought. This, however, would have necessitated a reservoir with a capacity of 4,500,000 cubic metres, and it would cost three times more than the construction, say, of the Dhuis aqueduct. Moreover, the water would be liable to contamination, and might be a source of danger to the health of the city. It is thus preferable and more economical to bring the water direct from new springs. In two years' time the completion of the works for utilising the sources of the Loing and the Lunain will suffice for the normal needs by increasing the minimum total of spring water from 200,000 cubic metres to about 250,000 metres, and with this additional pressure it will be possible to send the water at all times to the highest points in Paris.

The Exhibition of 1900, however, has rendered it necessary to augment the existing supplies of spring water with 65,000 cubic metres a day of filtered water. As the result of a competition organised a little while ago, the Municipal Council has come to the conclusion that the only way of satisfactorily dealing with the river water is by filtering it through beds of sand. The capacity of the Saint-Maur sand basins is at present 20,000 cubic metres, and this is to be increased before long to 30,000 or 40,000 cubic metres. It is found inadvisable to take more than this quantity from the river Marne, and the new basins are to be established near the Seine at Ivry. Eventually the filtering basins will have a capacity of 100,000 cubic metres, which will represent a quarter of the entire supply of water estimated to be available in 1930. To complete this distribution of 400,000 metres of pure water it will be necessary, as we said, to utilise fresh sources capable of furnishing about 160,000 cubic metres a day. The proposal to bring water from the springs of the Aube, the Yonne, and the Seine, which are capable of furnishing all that is necessary, will only be recommended by the engineers as a last resource, owing to the strong local opposition that has to be met with, and the heavy expense that would probably have to be incurred in indemnities and the like. They have therefore revived an old project for utilising the water which exists in the vast subterranean galleries near Orleans. For a distance of forty-one kilometres before entering Orleans the river Loire gradually decreases in volume by the filtration of the water through the gravel and loose calcareous beds of the valley, and the water rises again nine kilometres below Orleans to swell the Loire and the Loiret, where the volume is about the same as at the point where the filtration begins. The town of Orleans obtains its water from this natural reservoir; and it is estimated that Paris might procure no less than 432,000 cubic metres a day, so that not only would the city be abundantly supplied with spring water, but there would be enough for distribution in the suburbs. As this amount represents a fifth of the volume of the Loire at its lowest water level, it is evident that such a heavy drain would cause serious inconvenience during a period of drought, especially in view of the agitation now being carried on to render the Loire navigable for vessels of light draught, and in order to overcome this drawback it would be necessary to construct dams across some of the upper valleys of the Allier and the Loire to form reservoirs with a total capacity of 50,000,000 cubic metres, or sufficient to feed the river during a month of drought. The Commission, which has already examined this project, estimates that the cost of these works will not exceed £4,800,000. According to analyses of water taken from the calcareous beds through which it has filtered the quality is excellent; but upon this point, as upon many others, the new Commission lately appointed to examine all the various schemes will make further investigation before recommending the adoption or otherwise of this important project. In the meantime, it is proposed to build an additional reservoir in Paris so as to obviate the necessity of using the Seine water for domestic purposes during the hot months of the year, when the heavily-increased consumption coincides with a fall in the yield from the various springs, and it is pointed out that such a reservoir would enable the Council to spread the works over a longer period than would otherwise be possible.

The programme of the Paris Municipal Council to be carried out before 1900 is as follows:—The construction of aqueducts from the Loing and the Lunain, which has already been started upon, and is to be completed in two years; the construction of filtering basins, bringing up the total capacity to 65,000 cubic metres of filtered water a day; the provision of a reserve of river water equal to 130,000 cubic metres a day; the preparation of plans for bringing a fresh supply of 160,000 cubic metres of spring water to Paris; and the carrying out of the works of distribution in the city. It is estimated that this programme will entail an expenditure of £6,681,000. Of this sum £1,060,000 will be spent upon the Loing and Lunain works, and £1,168,000 upon the enlargement of the filtering basins at Saint-Maur and the creation of new basins at Ivry. A sum of £101,000 will also be devoted to strengthening the Vanne and Dhuis aqueducts and the acquirement of new springs. After 1900 the works will be carried out in two periods, when it is estimated that £3,120,000 will be spent upon new conduits and reservoirs, £100,000 for the completion of the filtering basins, and £660,000 for improvements to existing works. As regards the elevating and distributing installations for the water of the Seine a sum of £612,000 will be spent upon pumping machinery, syphons, reservoirs, and general improvements before 1900, and close upon £1,000,000 will be devoted to completing the system after that period.

THE BARRY DOCKS.

Dock No. 2, the point at which we had arrived in our remarks on Barry Docks in The Engineer of the 2nd inst., is from 400ft. to 600ft. wide, and from the northern side one can see the well-finished piece of masonry work that stretches along the other side, but a better view of this is obtained from a position at the west side. This wall is 3338ft. long, and 46ft. 6in. from the dock bottom to the coping; it is, too, perfectly straight and perpendicular, and its fine appearance elicited the praise of the visitors from the British Association. Figs. 12 to 16 set forth details of the construction of the dock walls; they are of rubble masonry. Fig. 14 illustrates the horizontal arrangement of the material; the top 20ft. has a punched face, and projects beyond the lower portion; the foundations are on marl or limestone, with or without the interposition of concrete, according to circumstances, as may be seen in Figs. 13, 15, and 16. It will also be observed that the thickness of the wall varies from 8ft. 8in. to 16ft. or 17ft., according to the character of the ground at the back; dry filling being freely adopted wherever desirable. Figs. 13, 15, and 16 also show the arrangement of the hydraulic mains and pipes, bedded on six to one cement concrete at the back of the wall and under the crane road. This side of the dock is reserved for import trade, for which ample sidings, sheds, and warehouses, with quay space 600ft. deep, are being provided. There are on this quay twenty-one movable hydraulic pedestal cranes, a 500ft. by 160ft. transit shed near the centre, and the construction of a cold storage depôt is contemplated at the east end, a little to the south of which is the hydraulic engine house for working this dock. It was specially noticed by some that at the far east-end of Dock No. 2 the wall was not continuous, but was broken by an entrance 80ft. wide, visible in Fig. 2. This entrance is temporarily built up from below, to such a height as to leave a depth of 5ft. at high water of ordinary neap tides; it leads to a timber pond, six acres in extent, which is encircled by a railway embankment on the eastern side, as shown in the plan, Fig. 1, p. 536. There is, however, a passage through the embankment, which is 20ft. wide, it is to be provided with a gate, and leads to a further timber pond of an area of 35 acres. This pond is nothing more or less than a prospective provision for a still further future extension of the Barry Dock, hence the 80ft. of entrance, and is known as Sir John Wolfe Barry's egg. In the meantime it is to serve as a store of water for locking at low tide; the space used at the present time for that purpose to the west of the main dock is now being filled up.

From the inspection of the south quay and its equipments the visitors passed by the south side of No. 3 basin, which is 800ft. by 700ft., or seven acres in extent, over the gates of the main entrance on to the Lady Windsor Deep-sea Lock, which leads direct from the sea to Dock No. 1, and is undoubtedly one of the most striking of the new works. It is shown in plan along with the contiguous portions of the main entrance, &c., in Fig. 17, and in longitudinal section in Fig. 18; it is 647ft. in length between the sills of the outer and inner gates; its depth is 60ft., and its width 65ft.; to save water in locking, it is divided by a pair of middle gates into two locks of the same width and depth, but the outer 233ft. long, and the inner 414ft. long. The sill at the inner gates is the same level as that of the main entrance, namely, 1ft. below the bottom of the dock, but at the middle and outer gates the sill level is 12ft. lower. The advantage gained by this is that, although the main entrance is 15ft. wider, the depth of water in the new lock at low water ordinary spring tides is 16ft. 7in.,

Fig. 12 Fig. 13 Fig. 15 Fig. 16

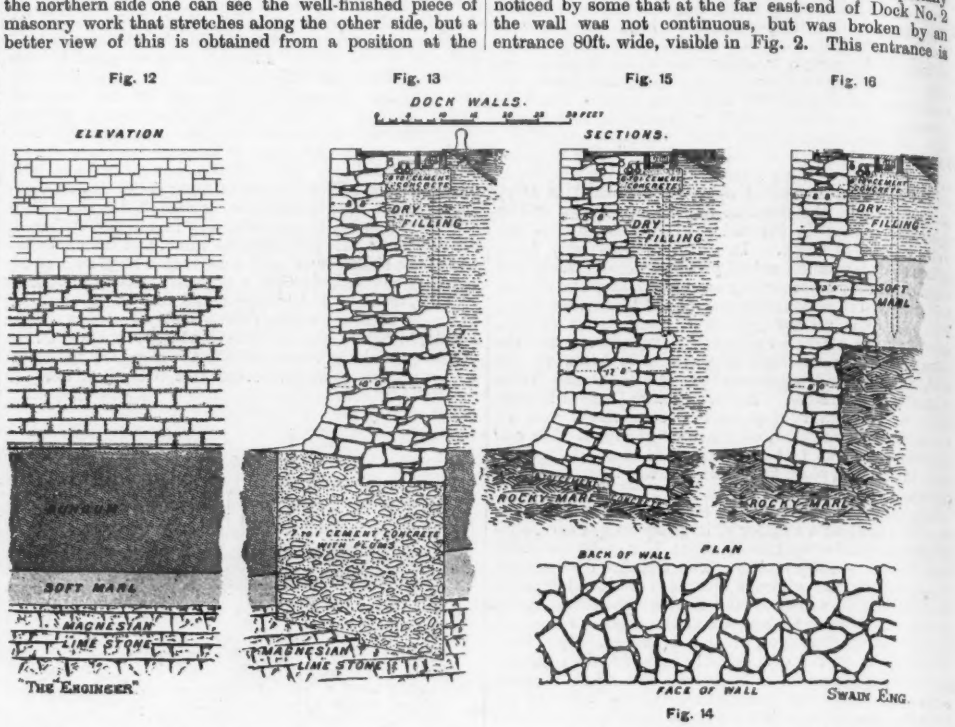


Fig. 14

Fig. 17

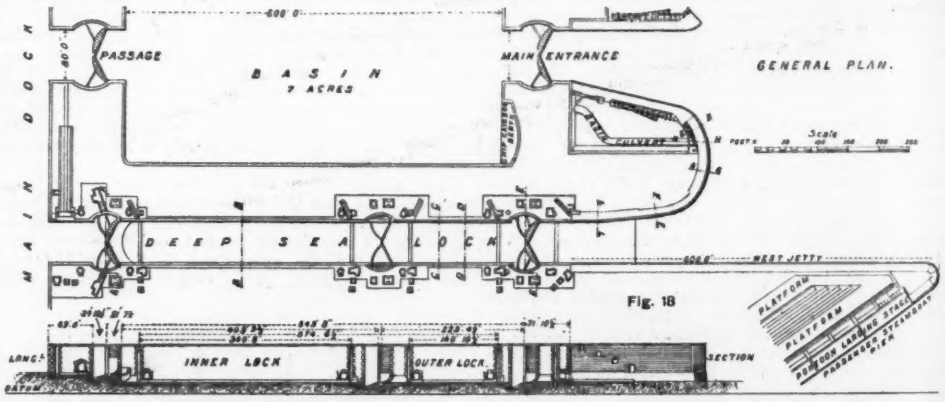
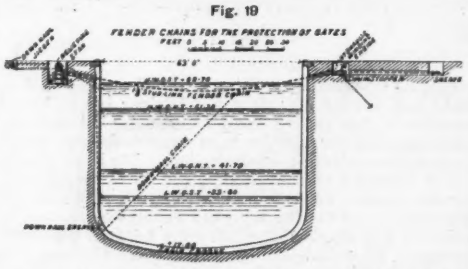


Fig. 18

Fig. 19



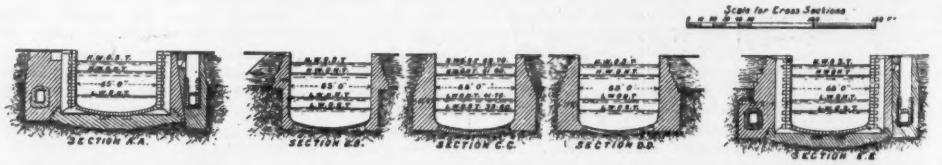


Fig. 20 Fig. 23 Fig. 24 Fig. 25 Fig. 22

and at low water ordinary neap tides 24ft. 9in., so that with the very rapid rise at spring tides the lock is practically rendered accessible to vessels entering for cargo during the whole twenty-four hours. Figs. 17 and 18 show the general arrangements, the gates, the gate chambers, the culverts, the fender chain grooves, also the guiding jetties, one to the west 600ft. long, and various incidental dimensions. Also the rolling bridge that takes the rail and road traffic over the dock end of Lady Windsor Lock.

In Fig. 17 the middle gates are shown open, the inner

Fig. 21—GATE CHAMBER IN COURSE OF CONSTRUCTION

and outer gates being closed; the straight parallel double lines across the lock show the position of the fender chain grooves; their position in the walls is indicated in Fig. 18, whilst Fig. 19 gives more details in this direction. The fender chains are 1⅛in. stud link, and are to protect the gates when closed from approaching ships; they are held in position and manipulated in the manner indicated,

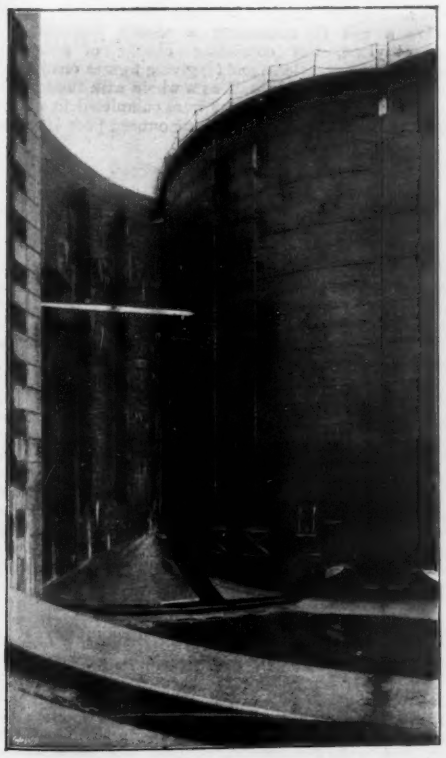


Fig. 26—GATE CLOSED

that is, they are held by clamps and worked by down-haul gear and by an hydraulic winding engine. The upper jaw of the chain stopper or clamp, on the right, is raised by a lever while the winding engine is raising or lowering the fender chain; but when the jaw is down the chain is fixed at that end, and therefore any giving to pressure from a ship must come from the other end, marked relieving gear in the figure. This consists of a drum round which the fender chain passes four times, with a length of slack between the third and fourth turns and to finish with. A smaller cylinder above the drum is free to move up and down, but is provided with volute springs adjusted to exert a downward force of about 40 tons on the fender chain, which, under the circumstances, can only slacken out a link at a time when a ship moves against it; the end of the chain is fastened into the masonry of the pit. The down haul chain is worked by the hydraulic down-haul jigger, and serves to hold the fender chain in the groove out of the way, when it is down for the passage of a ship. Fig. 19 also shows the levels in the lock corresponding to high-water ordinary spring tide +69·70, high-water ordinary neap tide +61·30, low-water ordinary neap tide +41·70, and low-water ordinary spring tide +33·60; the level at the invert being +17·00. The inverts are from 9in. to 3ft. 4½in. thick, and serve as a protection against the scour from the culverts in the side walls and gates.

Fig. 18 also shows the arrangement of the gate chambers, and Figs. 20, 21, and 22 show more particulars in this direction, the first and last being cross sections of the inner and outer finished chambers, Fig. 21 being a view of the middle gate chamber in course of construction. The floors of the gate chambers have an average thickness of 7ft. 6in. of brickwork, laid on a foundation of 3 to 1

Fig. 27—ROLLER AND CULVERT

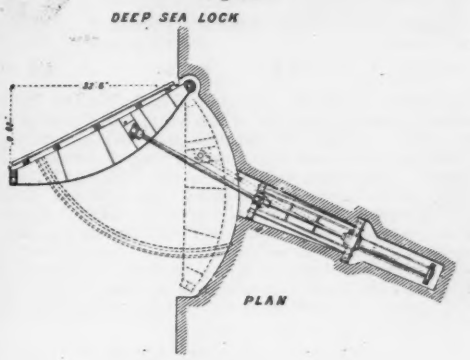
cement concrete, the two uppermost layers being of brindle bricks. In Fig. 21 may be seen the manner of dealing with inflows of salt water which escaped from fissures encountered during the excavation. The inflow illustrated was the largest of these; it had a head of 19ft., and required a 12in. pipe to carry away the water. Wherever found, whether at the back of walls or under inverts, the water was carefully collected and led through the work by means of cast iron pipes brought out to the face and fitted at the open ends with gun-metal flap valves.

The earthwork in the present case consisted of hard and soft red marl and magnesium limestone, and the walls of the dock, which are of mountain limestone vary in thickness in accordance with the character of the surrounding country, being as low as 6ft., as seen in Fig. 23, in the inner dock where the rock was hard and solid.

Figs. 20 and 22 give a good idea of the arrangement of the walls, culverts, floors, &c., at the gate chambers, and of the modifications introduced, to suit prevailing conditions. This factor is also demonstrated in Figs. 23, 24, and 25, which refer to cross sections at other parts of the lock, and it will be seen that it was found expedient to introduce much variation in the character of the construction at many points. The sills, groynes, and coping are of granite, and there is a raised bull nose at the edge on the top of the coping to provide a foothold for men when hauling at a rope.

Turning now to the gates, the three pairs are similar, beyond the inner pairs having fewer decks, for reasons already given. The gates, Fig. 26, are built of iron plates and angles, and are stiffened vertically by three bulkheads running from top to bottom, and horizontally by plate and braced decks, of which there are fifteen in the inner gates and twenty in the other cases. Each gate has six water-tight compartments, which form the air chambers to give buoyancy to the gates. The top deck and fendering are of wood, the heel posts, meeting posts, and sill pits of greenheart. Each gate measures 40ft. from outside of heel post to outside of meeting post, and is

Fig. 28



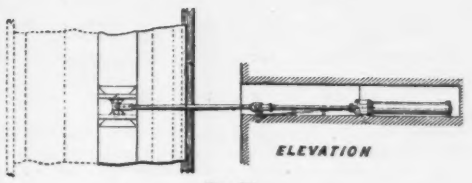
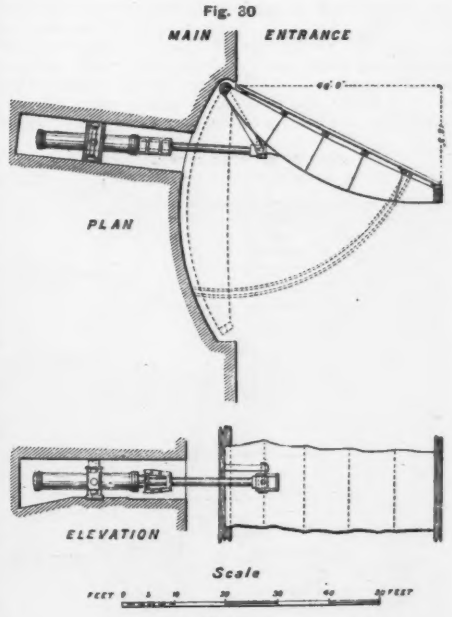


Fig. 29

Fig. 30



Scale

Fig. 31

8ft. thick at its centre, the height of the outer and middle gate being 56ft. 6in. at the heel post, and 60ft. 9in. at the meeting post. At the outer end of each gate there is a roller fixed in a detachable carriage, seen in Fig. 26, and better still in Fig. 27; it works on a wrought steel roller path. The anchorage of the gate is, however, strong enough to carry the gate with the roller removed. The gates are opened and closed by double-acting hydraulic cylinders, of which the piston-rod has a crosshead moving between steel side guides, all built in the ram chamber at the back of the gate recess—Figs. 28 and 29. This crosshead is coupled to the gate by a connecting-rod—seen also in Fig. 26—and the thrust of the gate is taken by one of the side guides. The piston is 19in. in diameter, with a 14ft. stroke; automatic cut-off gear is also provided, and the working pressure can be adjusted to anything between 200 lb. and 700 lb. per square inch. This is different to the arrangement adopted at the main entrance, and which for contrast is given in Figs. 30 and 31. It will be seen that in this case the piston-rod itself is connected to the gates, and the cylinder does the oscillating, for which purpose trunnions are cast on it vertically and horizontally, which project above and below, and pivot in saddle bearings, having trunnions on their side, which in their turn pivot in bearings fixed in the masonry of the walls of the ram chamber. In

Figs. 26 and 27 the culverts in the gates are shown—in the one case closed, in the other open. These sluices, of which there are four in each pair of gates, have a total area of 42 square feet, and are chiefly used to keep the inverts clear of mud. The large sluice culverts, which pass round the back of each gate chamber—Figs. 18, 20, and 22—have an area of 120 square feet. In locking out the water is lowered 6ft. a minute; in locking in it is raised 3ft. a minute. Vessels drawing 13ft. of water can enter and leave the dock through Lady Windsor Lock at low-water ordinary spring tides, and vessels drawing 18ft. can enter and leave at low water during fifteen days in each month.

Passing now to work outside the dock, there are the jetties; the one to the east curves round and joins the west jetty at the main entrance; that to the west extends seawards 600ft. in continuation of the straight line of the west wall. Figs. 32, 33, 34, 35, and 36 exhibit the character of the construction employed in the east jetty and the modifications incident to the prevailing

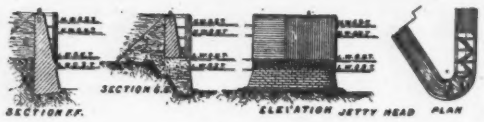


Fig. 33 Fig. 34 Fig. 38 Fig. 39

conditions. From the east side of Lady Windsor Lock round to near the junction of this jetty, with the jetty of the main entrance the structure is a wall of masonry built in cement and faced with a framed facework of timber. At places, such as L L, and F F, Fig. 17, the wall rests directly on the solid rock, with lias stone filling sloping off behind, and over it dry filling, as seen in the sections, Figs. 32 and 33; at other places, such as G G, Fig. 17, the wall rests on foundations of four to one concrete in bags, which are built up to low-water level, and are backed by mountain limestone filling, the wall rising above with the usual backing, as shown in the

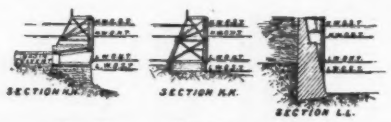


Fig. 35 Fig. 36 Fig. 32

section, Fig. 34; henceforth the structure is still further modified, and consists of the cement foundation to low-water level, with a timber superstructure, as shown in sections, Figs. 35 and 36, which are taken respectively at H H, and K K, Fig. 17.

The character of the work on the west jetty is well seen in Fig. 37, where the rocky marl bed is reached; the massive foundations of four to one cement concrete in bags and in bulk; the wall running above it perpendicular behind and with a batter of one in five in front; the mountain limestone filling, the lias stone filling, and the dry filling, may all be distinguished.

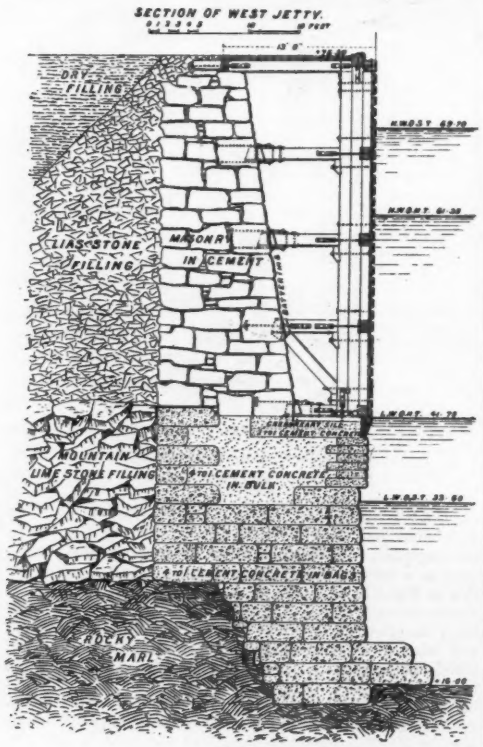

SECTION OF WEST JETTY.
DRY FILLING
MASONRY IN CEMENT
LIAS STONE FILLING
MOUNTAIN LIME STONE FILLING
4 TO 1 CEMENT CONCRETE IN BULK
4 TO 1 CEMENT CONCRETE IN BAGS
ROCKY MARL

Fig. 37

The character of the timber frame and face work, with the greenheart sill on two to one cement concrete, is duly set forth, as well as the water levels; whilst Figs. 38 and 39 show the elevation and plan of the head of the west jetty. At the back of this jetty, or on the western side of it, as shown in Fig. 17, are situated the platforms, &c., of a station of the Barry Island Railway, and pontoon landing-stages intended for Channel passenger steamboat traffic. The depth of water here at low-water ordinary spring tides is 11ft. 9in. A tunnel 287 yards long connects this station with the rest of the Barry Island Railway—plan, Fig. 1—which continues through Barry Island Station, then by the steel viaduct, 150 yards long and 24ft. spans, over the dock coal sidings to the embankment crossing the old channel, and terminates at Barry Station. The masonry breakwater at the western point of the island is 150 yards long, and protects the railway embankment and old harbour. This railway, as far as Barry Island Station, was opened on August bank holiday, 1896, on which day over 29,000 passengers passed over it. It was visited on the occasion now being noticed after luncheon, and the pretty view, nice sands, and geological sections of Whitmore Bay were thoroughly enjoyed.

ACETYLENE *v.* ETHYLENE.

At intervals since the commencement of the year there have appeared in various directions sundry semi-lucid hints that a new carbide has been discovered, which yields on treatment with water a gas of higher illuminating power than acetylene, and which incidentally, therefore, already threatens with extinction a small but promising industry that is only just beginning to "feel its feet." A Mr. Hartenstein, of Bellaire, Ohio, has taken out patents for the manufacture of a carbide from blast furnace slag, by adding carbon and heating the mixture in an electric furnace in the same fashion as is done in the preparation of calcium carbide. This new material is designated "Carbolite," and certain persons—whether the inventor or not is still obscure—have claimed that it can be made for five dollars per ton, that it yields ethylene, otherwise known as olefiant gas, when immersed in water, and that ethylene is a more powerful illuminant than acetylene. Authoritative and satisfactory details respecting the process have not yet been made public; but seeing that the idea is being largely written about already, and wild speculations are being freely indulged in regarding the prospects of carbolite as a future article of commerce, it may be well to explain the present state of knowledge on the subject of carbides and the gas ethylene.

Calcium carbide is only one of a large number of similar compounds which are now, principally owing to the valuable researches carried out by M. Moissan with the aid of his electric furnace, recognised by chemists. Not all of these behave like the calcium salt on addition of water. Some, such as the carbides of molybdenum, tungsten, and chromium, are not decomposed at ordinary temperatures; silicon carbide, an analogous product but with a non-metallic base, is also unattacked, and forms the highly serviceable abrasive material called "carborundum," which is widely used in the States as a substitute for emery. Aluminium carbide yields pure methane—marsh gas; the carbides of the alkali and alkaline earth metals, of which calcium is one, all evolve pure acetylene; those of the rare cerium group of metals produce a mixture of methane and acetylene; the carbides of manganese and uranium alone have hitherto been found to give off any ethylene, and they yield methane and free hydrogen at the same time. It therefore appears highly improbable that carbolite, or any other carbide which can conceivably be turned out at a merchantable price, can actually produce the real hydrocarbon ethylene in noteworthy proportion; but assuming for the sake of argument that such is nevertheless the case, the position of ethylene *versus* acetylene may be briefly summed up as follows.

Ethylene is a colourless gas, having a faint ethereal odour when it is pure. It contains about 6·5 per cent. less carbon than acetylene, and it should accordingly be a trifle easier to burn and less liable to emit smoke in an unsuitable burner; but its luminosity is lower than that of its rival. It requires three times its volume of oxygen for perfect combustion instead of 2·5; and this extra consumption of the atmosphere would be still further increased in practice owing to the larger amount of gas needed to yield an equivalent quantity of light. According to Lewes, burning ethylene begins to give light at a slightly lower temperature than acetylene, but the temperatures of the other parts of the flame are materially higher, although they are all below those observed in the corresponding positions of the coal-gas flame. In Table I. are exhibited Professor Lewes' results, which he considers to be some 100 deg. or 200 deg. too low, by reason of the cooling action of the wire of the thermo-couple employed in making the determinations.

Table I.

Temperature of Various Gas Flames.

	Acetylene. deg. Cent.	Ethylene. deg. Cent.	Coal-gas. deg. Cent.
Non-luminous zone	459	952	1023
Commencement of luminosity	1411	1340	1658
Near top of luminous zone	1517	1865	2116

It will be observed that, viewing heat as an objectionable by-product in the evolution of light, acetylene is distinctly the best of the three illuminants; for if it be lawful to average the figures appertaining to each flame, the mean temperature of burning acetylene is, roughly, 2100 deg.; of ethylene, 2500 deg.; and of coal gas, 2900 deg.; whereas the illuminating power falls as the temperature rises.

The limits of explosibility in presence of air, as determined by Clowes, for ethylene and several other gases, are given in Table II., where the risk evidently increases in the order set down from the comparatively safe methane to the relatively dangerous acetylene. The figures quoted for the latter gas are not quite the same as those recorded by other investigators; but without entering into the question as to which are the most correct, Dr. Clowes' results have been selected for insertion on the present occasion because they were deduced under identical conditions, and therefore being absolutely comparable one with another, afford the best opportunity of contrasting the properties of these several gases. An inspection of Table II. shows that with the exception of carbonic oxide and water-gas, which are not at the moment under review, the inferior limits are all very similar, and the main variations are at the upper end of the scale. Now, in ordinary circumstances, a gas explosion is always caused by an escape from a leaky pipe, a water-sealed chandelier that has become dry, or an open cock. All these events naturally lead to a mixture of inflammable gas with a large excess of air; and, assuming a light to be present, explosion takes place when the lower limit is reached. The upper limit of explosibility can only be attained in practice if air enters the pipes—which is very unlikely—or if it is not completely driven out of the generating apparatus before the gas is admittted to the service.

Table II.

Limits and Range of Explosibility.

	Lower limit Per cent.	Upper limit Per cent.	Range Per cent.
Methane	5	13	8
Ethylene	4	22	18
Coal gas	5	28	23
Water gas	9	55	46
Carbonic oxide	13	75	62
Hydrogen	5	72	67
Acetylene	3	81	78

The latter contingency may easily occur with any illuminant prepared domestically, either through the use of a badly designed generator, or through carelessness in manipulating it; but the danger can as easily be avoided by selecting the proper kind of apparatus in the first instance, and placing it in the charge of some reasonably intelligent attendant. The practical relative danger of explosion with acetylene, ethylene, and coal gas, disregarding the extra speed at which the latter will escape because of the larger burners used for consuming it, and its lower specific gravity, therefore is as 5 : 4 : 3; the total or absolute danger is as 78 : 18 : 23. The actual illuminating value of ethylene does not seem yet to have been determined, so that these figures cannot be corrected for the size of the orifices, &c.; but supposing it to be only slightly below that of acetylene, the advantage of ethylene on the score of safety is manifestly more apparent than real. Moreover, now that it is fully realised that all possible illuminants become explosives if unfairly handled, and that no apparatus can be made "fool-proof," to quote the current elegant phrase, there is as yet not much reason to fear that acetylene will only "blaze the comet of a season."

Returning now to the mysterious substance "carbolite." As aluminium carbide when treated with water gives off methane, if this carbide be mixed with an acetylene-yielding carbide (*e.g.*, calcium) in such proportion that the resulting gas consists of equal volumes of acetylene and methane, the said gas will have the same percentage composition as true ethylene, although the latter is entirely absent. This is explained in Table III., which records the chemical formulæ and percentage composition of the three hydrocarbons acetylene, ethylene, and marsh gas. For a gas composed of equal parts by volume of acetylene and marsh gas may be represented by the symbols ($C_2H_2 + CH_4$), which corresponds to 85·7 per cent. of hydrogen and 14·3 per cent. of carbon—the same arithmetically, though by no means chemically, as $1\frac{1}{2}\ C_2H_4$. By accident, also, or by the exercise of some ingenuity, a mixture of the carbides of calcium, aluminium, and manganese might be prepared, which should evolve a gas (1) containing a certain proportion of true ethylene, but consisting chiefly of hydrogen, methane, and acetylene, and (2) giving figures on ultimate analysis agreeing fairly well as a whole with the formula $C_2 + H_4$; and if such a gas were submitted to a hasty examination it might easily be pronounced pure ethylene.

Table III.

Percentage Composition of Gases.

	Formula.	C per cent.	H per cent.
Acetylene	C_2H_2	92·3	7·7
Ethylene	C_2H_4	85·7	14·3
Methane	CH_4	75·0	25·0

This, then, is probably the real nature of the gaseous product yielded by carbolite, viz., a mixture of acetylene, methane, and hydrogen, with or without a small percentage of ethylene. As an illuminant it should rank between pure acetylene and the diluted gas, or mixture of acetylene, methane, and water gas recommended by Professor Lewes; being, in fact, very similar to the latter, but with perhaps less hydrogen and no carbonic oxide. It cannot have a higher illuminating value than acetylene; but as a slightly weaker light-giving body may be found suitable for adoption in some places. As to its hygienic, pecuniary, and therefore industrial value, nothing can be said definitely at present until further information is vouchsafed regarding the obnoxious impurities that may possibly accompany its evolution, the actual yield per pound of carbolite, its practical candle-power, and the real price at which it can be put on the market.

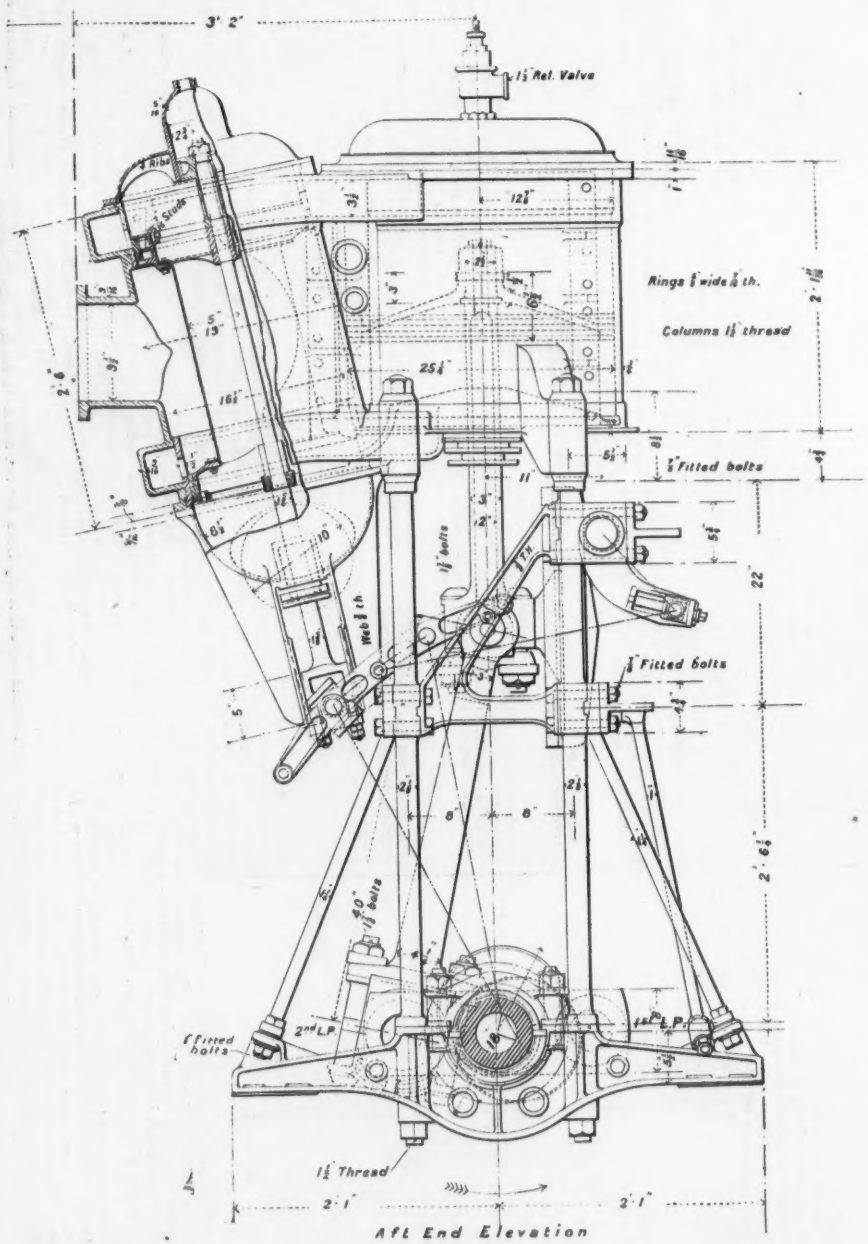
TORPEDO BOATS FOR THE UNITED STATES NAVY.

We give on page 585 further views of the engines of the new American torpedo boats of which we gave a plan and elevation last week. The high and intermediate-pressure cylinders of these engines will be in one casting, and each low-pressure cylinder will be a separate casting, the lower heads being cast with the cylinders. The metal in the barrels will be $\frac{3}{8}$in. thick. The upper covers will be of $\frac{3}{8}$in. cast steel, each fitted with a relief valve, and these covers will be secured to the cylinders by $\frac{3}{4}$in. studs of forged steel. The clearance between pistons and cylinders will be $\frac{5}{16}$in. at top, and $\frac{7}{16}$in. at bottom. The intermediate and low-pressure valve chests will have 1$\frac{1}{4}$in. adjustable spring safety valves, loaded to 110 lb. and 50 lb. respectively. Each chest will have a cast iron lining forced in. The exhaust passage from the high-pressure to the intermediate cylinder will be 7$\frac{1}{4}$in. diameter, formed in the casting. The passage from the intermediate cylinder will be contained in the lower valve chest bonnets, and will be 10$\frac{1}{2}$in. diameter to the first low pressure, and 10in. to the second low-pressure cylinder.

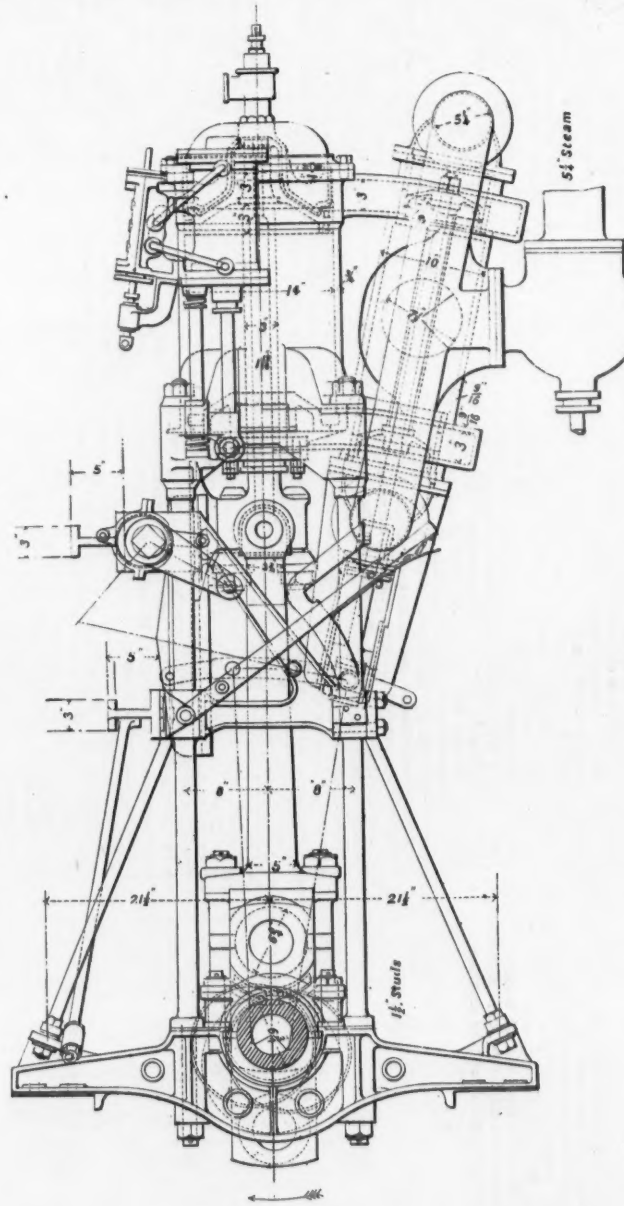
The piston valves will have cast iron heads. That of the

TORPEDO BOAT ENGINES, UNITED STATES NAVY

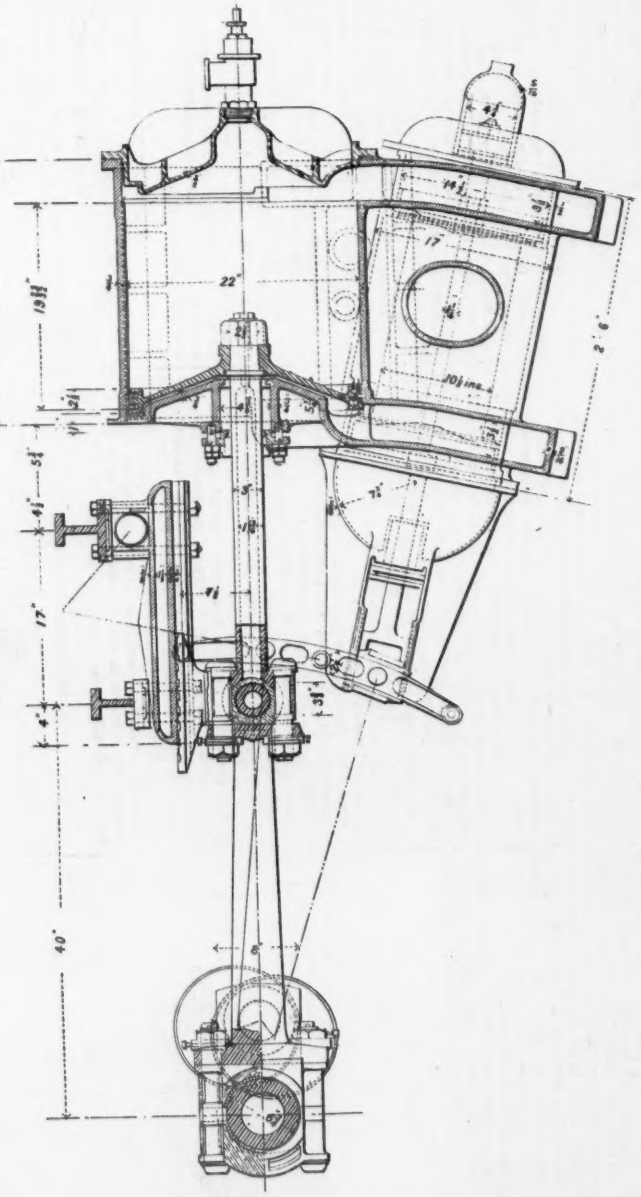
(For description see page 584)



Aft End Elevation
Looking Forward.



Forward End
Elevation.

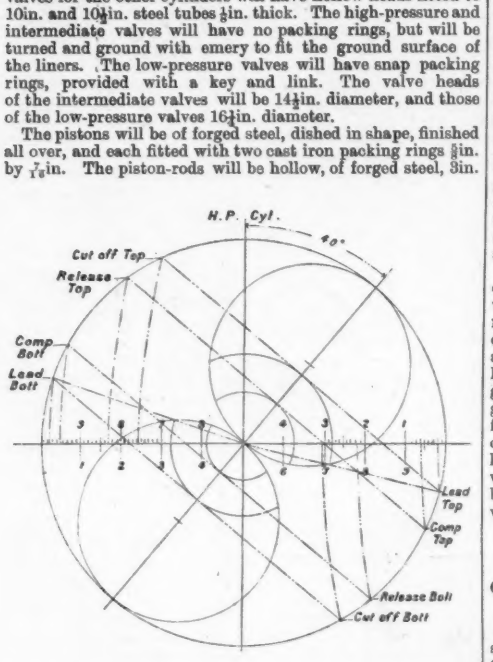


Section at A.B.

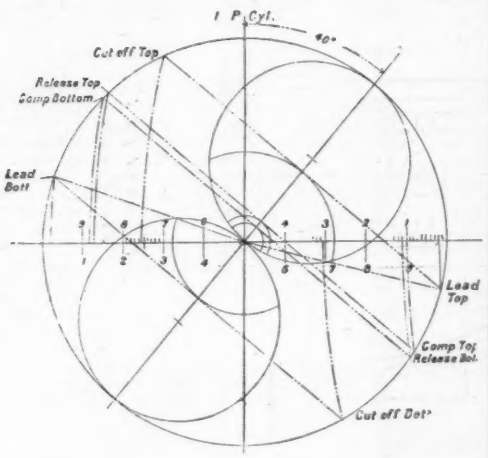
SWAIN ENG.

high-pressure cylinder will have solid heads fitted to a forged steel distance piece, the heads being 7½in. diameter. The valves for the other cylinders will have hollow heads fitted to 10in. and 10½in. steel tubes ⅝in. thick. The high-pressure and intermediate valves will have no packing rings, but will be turned and ground with emery to fit the ground surface of the liners. The low-pressure valves will have snap packing rings, provided with a key and link. The valve heads of the intermediate valves will be 14½in. diameter, and those of the low-pressure valves 16½in. diameter.

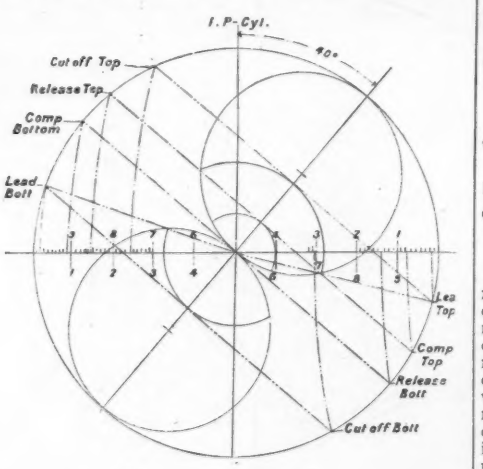
The pistons will be of forged steel, dished in shape, finished all over, and each fitted with two cast iron packing rings ⅝in. by 7/8in. The piston-rods will be hollow, of forged steel, 3in.



diameter, with an inside diameter of 1⅛ in. for the high and intermediate-pressure cylinders, and 2in. for the low-pressure. Each piston-rod will have its crosshead forged on, and each crosshead will have a slipper 7½in. by 13½in. for the first two, and 6½in. by 11½in. for the other two cylinders. The go-ahead side of each slipper will be faced with white metal. The connecting-rods will be flat, of forged steel, 40in. long centre to centre, with crosshead pins shrunk in.



The valve gear will be of the Stephenson type, with double bar links, the gear being so adjusted that the mean cut-off will be about 71 per cent. of the stroke with the links in full gear. All valves will be worked direct, and the link motion will be of the crossed rod type, with links suspended from the middle. The excentrics will be forged solid with the shaft, with a throw of 4½in., and will be recessed at each side



for the flanges of the excentric straps. The reversing engine will have a slide valve worked by a differential gear composed of an excentric made solid with the reversing shaft, and connected to the valve and hand lever by means of links, so adjusted that the piston of the engine will follow the motion of the hand lever.

There seems to be no attempt to balance the engines, except by placing the cranks opposite each other, the high-pressure opposite the mean-pressure, and the two low-pressures opposite each other. The cylinders are not lined or jacketed, and there is nothing particular about the pistons, but the four piston valves are arranged in the most remarkable fashion, doubtless for the purpose of saving length in the engine-rooms. As will be seen, they slope downwards in the direction of the crank shaft, but by no means in the direction of its centre line, for only the high-pressure rod seems to do that; the centre lines through the others appear to pass many inches sideways of the centre line of the crank shaft. This peculiar arrangement causes, of course, considerable side strains on the valve rods, which necessitates formidable guides below their stuffing-boxes. All this is done to save length fore and aft. Is the game worth the candle? The link motion is of the usual bar link type, and there is the—in the United States now quite usual—direct steam reversing gear, with a 5in. cylinder, 8½in stroke. We believe this class of reversing gear is found satisfactory. The crank shaft is 6⅜in. diameter, bored to 4in. We should have preferred for such small engines, solid shafts, as they would have been smaller and caused less friction.

One of the most striking features of these engines are the connecting-rods, which are flat bars, wide and thin to give, we suppose, elasticity in a fore-and-aft direction. M. Normand, of Havre, did this many years ago in a somewhat different manner, but English engineers do not seem to find any necessity for such an arrangement. The piston-rods are lightened by boring to a rather unusual extent. The slipper guides are rather narrow, but seem to make up surface by great depth. The air pump is very similar to that designed for the new American destroyers illustrated in THE ENGINEER of October 21st. In point of safety the general arrangement has much in its favour, as the total engine space has three water-tight bulkheads, and there is no longitudinal bulkhead between the engines to cause water leaking in to give the vessel a dangerous list.

GLASGOW AND THE CONDUIT SYSTEM OF ELECTRIC TRACTION.

THE wisdom conveyed in the advice which says "hasten slowly" would seem to be exemplified in the experience of Glasgow with regard to electric traction, although this is as yet but limited. It is only about a month since the opening of its first length of electric tramway on the overhead trolley span-wire system—details and illustrations of which we propose giving in an early issue—and although the results of working so far are highly satisfactory, practically and financially, the Corporation have seen it to be advisable to abandon, meantime, a contemplated extension of the trolley system in favour of delay and further consideration of the conduit system. Mr. John Young, the general manager of the tramways—whose services have not been secured by the London County Council—in reporting recently on the working results on the line already constructed, and on the proposal to equip a further stretch of tramway on the same principle, asked whether this extension should be on the overhead or the underground system, or rather, whether there should be a demonstration of the conduit system before finally discussing a complete scheme of electric traction for the city. He referred to figures recently made public as to the comparative costs and profits of cable electric conduit and horse tramway operations in New York City, as apparently confirming the commercial success of the conduit system in that city of great traffic, and its great superiority to cable and horse traction. Regarding the question as to what would be involved in converting the present permanent way of the Glasgow tramways, and equipping same electrically for both overhead and conduit systems, the report stated that the total length of the tramways owned by the Glasgow Corporation, including those recently constructed, although not yet open for traffic, measured thirty-seven miles of double track. Prior to 1894 the section of rail used weighed 79 lb. per yard, and from 1894 to 1896, 89 lb. per yard. Since 1896 a new section had been adopted, weighing 100 lb. per yard. Experience in re-laying and operating the Springburn route had practically dispelled any hopes that might have been entertained of the economy of bonding and wearing out any considerable portion of these old shallow-grooved rails. In the event of conversion to electric traction twenty-eight miles would practically require new rails throughout, while the present rails on nine miles would be suitable for the new force of traction. On that basis Mr. Young had made up the following relative estimates of the cost of conversion. These estimates did not include anything for feeders, rolling stock, equipments, buildings, power and transforming stations, &c., which were common to both the overhead and conduit systems, and which might be estimated at equal cost.

Overhead.

	£	s.	d.
Renewing 28 miles of double track, and electrically equipping same, including overhead construction, bonding, and ducts for feeders, at £11,000 per mile	308,000	0	0
Converting nine miles of double track now laid with 100 lb. rails, at £4500 per mile	40,500	0	0
	£348,500	0	0

These figures for the overhead system are based upon the cost of converting the Springburn route.

Conduit.

	£	s.	d.
Renewing 28 miles double track, and electrically equipping same, at £20,000 per mile	560,000	0	0
Converting nine miles of double track, using the present rails, at £18,000 per mile	162,000	0	0
	£722,000	0	0

According to the present estimates, it would cost £373,500 more to convert the thirty-seven miles of double track under consideration to the conduit than to the overhead system, or rather more than double. The greatest sacrifice for the conduit system was in lifting to the foundation the lines more recently laid with 100 lb. rails. To construct the conduit on a road on which there were no tramways at present would probably cost about £6000 per mile, of double track, more than overhead. Taking an average running of 9,000,000 car miles per annum, or 122,000 per mile, of single track, the interest and sinking fund on the extra cost for conversion was practically equal to ½d. per car mile. There would probably be slight excesses on other points, such as maintenance, leakage, cleaning, &c., but the excess on all points would not in any event, exceed 1d. per car mile. On the mileage in question 1d. per car mile would amount to £37,500 per annum. Throughout Mr. Young's report, wherever the conduit system is under consideration, allusion is made to the depths available below the street surface for the formation of an electric conduit. The depth of the shallowest electric conduit yet formed, according to Mr. Young, is about 21in. Now the iron girders which support the leading east and west thoroughfares in Glasgow, above the Central Underground Railway, which traverses these thoroughfares for two and a-half miles of their length, are in some places only 10in. below the street surface, the average depth being about 16in. Railway bridges also form portions of many of the streets, and in their case the depth available is often scarcely more than that of the Central Railway. There is here, therefore, an initial difficulty, which—unless it can be overcome—must form a conclusive barrier against the adoption of the conduit system in Glasgow. So far at least as concerns the streets in which these limitations exist, Mr. Young contents himself with mentioning the facts, and declares it will be a question for engineers to decide whether this difficulty can be overcome. The feasibility and advisability of having, or at least experimenting with, both systems of traction has also received some attention. Referring to the proposed extension to the electric tramways, over a route presently laid with the ordinary rails, Mr. Young has reported that there was nothing—except, perhaps, insufficient depth on the bridges—to prevent a portion of this extension being altered to the conduit system, and the working of the same cars over both systems, if the Committee wished it. The cars would be fitted with the trolley for the overhead portion, and the plough for the conduit portion. The one would be thrown on and the other off at the junction—which would be a stopping place—without much detention. The changing might not be altogether desirable, but it was quite workable. One system, however, for the entire city would be preferable. Otherwise there would be difficulty in determining where one system should end and another begin.

THE INSTITUTION OF MINING AND METALLURGY, LONDON.

THIS Institution was founded to foster and further the dissemination of useful knowledge in connection with mining engineering and metallurgical matters, in so far as they refer to metals other than iron and to non-metallic minerals other than coal. Iron and coal are exceedingly well looked after by other institutions, whereas matters relating to metalliferous mining and metallurgy have been and are occasionally made the subject of papers before various learned societies, who accord them a gracious hospitality, a position of sufferance that, considering the importance of the subjects in question, became unbearable to those engaged in the industries concerned, and who felt that there should be some sort of institution where their particular topics could be always discussed and investigated without intruding on the patience and courtesy of others, although they highly appreciate the value and the importance of having many of the questions involved in metal mining and metallurgy set before other learned bodies, and to have the views of those bodies on such questions; but there are many smaller or special points that would scarcely interest other professional men, but which are of importance to the metal mining and metallurgical engineer. It is not surprising to find that the Institution, following such lines, is flourishing, and providing plenty of matter of interest for the members to study, without at all interfering with the presentation of mining and metallurgical matter elsewhere.

The "Transactions" of the seventh session, 1897-98, of the Institution, 348 pp., have recently been published from the head-quarters of the Institution at Broad-street House, E.C. The volume is very nicely got up, and reflects great credit on the editor, Mr. Arthur C. Claudet. The matter dealt with in twenty-five pages includes:—Some geological factors in their relation to mining; various accounts of mines in different parts of the world; milling and metallurgical questions; certain details of the cyanide process for the extraction of gold that require elucidation; the buying and sampling of ores in Chili; diamond drilling; shaft sinking, and various incidental matters. The particular merit is that all these matters are received and treated in a highly practical way, and the views expressed are, as a rule, the views entertained by men who are actually engaged in the application of the special knowledge; and therefore anybody requiring such practical views in connection with mining and metallurgical operations could scarcely do better than consult these "proceedings." Theoretical papers are, however, not ignored, as may be gathered from the remarks of the President on one occasion, when a non-practical paper had engaged the attention of the meeting. In course of his remarks he observed, in reference to the author's suggestion that "it was rather an exercise in mental gymnastics than in practical mining. They were, however, always glad to receive such papers, which showed that all parts of the science of mining was being attended to."

There is one feature of the volume that seems to require attention, that is, the index. In the present form it is simply an elaborated table of contents, and is certainly not of much use for aiding reference to the contents of the volume.

It is noteworthy that the Institution is progressing, the number of members recorded at the time of the seventh annual general meeting being 501, showing an increase of fifty-two over the roll of the preceding year. But in spite of all this, one cannot do otherwise than think that amalgamation with the Institution of Mining Engineers would be decidedly advantageous. Many mining problems would be far better considered by a meeting of both coal and metal mining men than by a meeting composed of members of one or the other branch of the profession. Then, again, practically the whole mining literature of the country would be included in the one set of "Transactions," which would obviate the reduplication of papers that one so often encounters and laments now-a-days, and, moreover, would give the professional man considerably less trouble in search for necessary information. Then, again, all papers would be open for discussion throughout the country; and finally, the Institution of Mining and Metallurgy in particular, while retaining its special attributes, would benefit by having the abstracts of papers from foreign sources, that form such a useful adjunct to the volumes of the "Transactions" of the Institution of Mining Engineers; and which, on the other hand, it would be a pity to reproduce in another English mining publication.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet Engineers: John P. Adams, to the Vivid (additional for training engineer student); Wm. H. Grant, to the Vivid (additional for the Temeraire); Thomas J. Haddy, to the Pembroke, for the Blenheim, and John Fielder, to the Pembroke, for Torpedo Depôt. Staff Engineer: David J. Bennett, to the Victory (additional for the Glory). Chief Engineer: Walter J. Warren, to the Australia, for service at Felpham. Probationary Assistant Engineer: Jonathan J. Screach, to the Proserpine.

SIR WILLIAM ANDERSON.

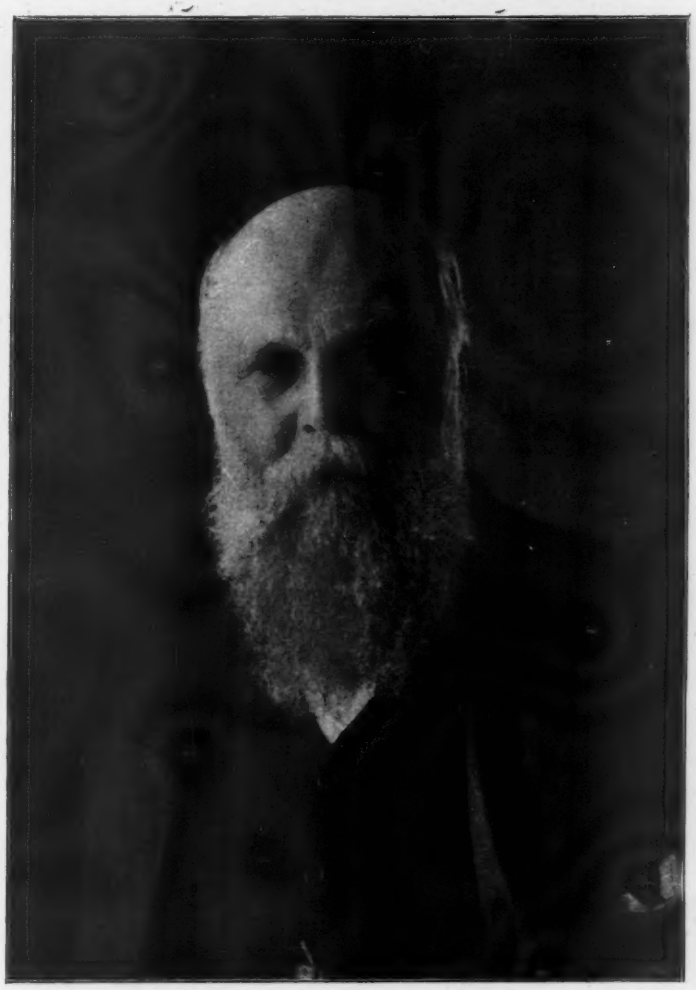
AFTER an illness lasting more than a year, Sir William Anderson, Director of Ordnance, died of heart disease in the early morning on Monday, at his official residence in Woolwich Arsenal. His death removes an engineer who has played a very considerable part on the world's stage. His father, Mr. John Anderson, was a St. Petersburg merchant. His mother was the daughter of Mr. Simpson. William Anderson was born in February, 1835, and lived in Russia until he was twelve years old. It has often been stated that unless a man is born and bred in Russia he can never speak the language properly. Sir William kept up his acquaintance with the language to the last, and he was on friendly, if not intimate terms with some of the most able men as engineers and artillerists in Russia. His perfect knowledge of the language enabled him to utilise Russian scientific literature, and he translated and published not a few valuable Russian papers. When he left St. Petersburg for England he was head of the school there and silver medallist, and the freedom of St. Petersburg was conferred on him. In 1849 he matriculated at King's College. There he carried everything before him, and after his three years' course he went as an apprentice to Sir W. Fairbairn, in Manchester. At that time he was seventeen. After his pupilage was over he went to Dublin, and subsequently, when of age, he went into partnership with Messrs. Courtney and Stephens, who carried on an iron foundry in Blackhall-place, wherein everything from railway chairs to ploughs was made. As time progressed, the firm launched out and executed some very considerable work, as, for example, the roof of the King's Bridge terminus of the Great Southern and Western Railway. Indeed, it is not too much to say that all the ironwork of importance done in Ireland for many years was executed either by Courtney and Stephens or Mallet. About this time the lattice girder was comparatively a new thing, and young Anderson took up the study of it with energy, and wrote more than one paper on the subject read before the Institution of Civil Engineers in Ireland, of which body he was elected president in 1863.

In 1864 Mr. Anderson left Ireland, which did not afford him an adequate opportunity for the exercise of his talents. He came over to this country and joined the firm of Easton and Amos, of Erith, which had already attained a considerable reputation as hydraulic engineers, the manufacture of the Montgolfier hydraulic ram and the Appold centrifugal pump being specialities. Thenceforward we find Anderson continuously in the front rank, promoting in a hundred ways the advancement of engineering science. It will be remembered that Messrs. Easton and Amos were the consulting engineers to the Royal Agricultural Society, and with their aid all the world-renowned trials of portable and other engines—in a word, of all the machinery of the farm—have been carried out. In all this Mr. Anderson took a prominent part. Various changes due to the death or retirement of partners took place, and finally the firm became Easton and Anderson, of London and Erith.

Anderson's connection with Russian artillerists, combined with his own natural bent, led him to turn much attention to guns. He did good work for Capt. Moncrief, and invented a disappearing gun carriage himself. He worked too with Vavasseur in his development of rifled ordnance. As one result he became himself a most accomplished artillerist. Associated with Sir Frederick Abel, he was one of the inventors of cordite, and it will be remembered that he was made the defendant in a celebrated patent action brought against him by the Maxim-Nordenfelt and Ammunition Co. and Mr. Hiram Maxim. The case was argued before Mr. Justice Wright in 1897, and judgment for the defendant was pronounced on March 4th. The judgment was published in our columns at the time. But this is to anticipate. It is necessary, however, to put Mr. Anderson's knowledge of guns and artillery generally prominently forward in order that an important event, not only in his, but we might almost say the national life, may be fully understood. For several years the management of Woolwich Gun Factories and Arsenal had been very unsatisfactory. This is not the place or the time to explain why. It is enough to say that the War-office and the Admiralty did not agree, and that much friction existed in the Arsenal itself. Things at last came to such a pass that in 1889 Mr. Stanhope, Secretary of State for War, decided on appointing a civilian engineer instead of a military man as Director-General of the Ordnance Factories, and Mr. Anderson was offered and accepted an appointment, for which he was eminently suited, not only because of his intimate knowledge of guns, but because of his considerable reputation as a man of science and his talents as an investigator. He was a Fellow of the Royal Society, and an honorary D.C.L. of Durham. At first his appointment raised a storm. Military men foolishly held that they had been slighted. The Arsenal had been a preserve for military men, and the introduction of a civilian was not to be tolerated. But Mr. Stanhope was firm, and in a little time even the malcontents began to see that the change was wholly for the better. The individuality of the man was the secret of Anderson's success. He combined great strength of character and absolute honesty of purpose with infinite tact. Unless Anderson wanted to quarrel, it was impossible to quarrel with him. He possessed to perfection the art of doing unpleasant things in a way to deprive them of all sting. In a very short time he became extremely popular in the Arsenal with all but a few. It was a curious turn of fate that the man who was at one time denounced because his rule was said to be too hard, was afterwards denounced because it was said to be too easy. Anderson cared little for criticism of this kind; he knew his work, and he did it honestly and fearlessly according to his light. It was not, indeed, until his health gave way that he took any heed of political criticism. The estimation in which he was held by the Government never waned, no matter which party was in power, and in 1897 he was made a Knight Commander of the Bath.

Sir William Anderson had a very large number of friends. Few men indeed who have played so important a part will be more sincerely regretted. He possessed an infinite charm of manner. His sincerity, his straightforwardness, his recognition of merit in others, always finding expression on his lips, combined with an almost feminine gentleness and courtesy, insensibly brought to his side even those most disposed at first to be antagonistic. And with all this there was, when need came, a masterful determination, and a quick and even fiery decision, which commanded respect on all hands. He did everything as well as he was able to do it, and that was one portion of the secret of his success in life. It sounds jejune to say that his place in this world will not easily be filled. It is none the less true. Nay, we do not hesitate to go so far as to say that it cannot be filled at all. As to his work in Erith, this is not the place to speak of it in detail. As his weekdays were devoted to the service of the nation, so his Sundays were spent in the service of the school children, for whom he worked indefatigably and unobtrusively. Heart and soul he was a Christian gentleman; one of the men who are the salt of the earth, and whose lives, like that of Clerk-Maxwell, are a standing proof that the highest attainments in science are in no way incompatible with a profound sense of religious duty. The great concourse, including as it did most of the eminent engineers and scientific men in London, which was present at his funeral on Wednesday was excellent testimony to the widespread esteem in which he was held. He was buried in the churchyard of the old parish church at Erith.

Mr. Anderson was elected member of the Institution of Civil Engineers on January 12th, 1869; member of Council, May, 1886; and vice-president, June, 1896. He delivered the James Forrest lecture on May 4th, 1893, taking for his subject "The Interdependence of Abstract Science and Engineering." In 1873 he read a paper on "The Aba-el-Wakf Sugar Factory, Upper Egypt;" in May, 1875, one on "Peat Works in Russia;" on January 16th, 1883, an elaborate paper on the "Antwerp Waterworks;" on December 6th, a very admirable paper on "The Generation of Steam." In connection with Mr. Ogston he wrote a paper on "The Purification of Water," which was printed with the "selected" papers of the Institution. It dealt with the system of revolving purifiers which Dr. Anderson had invented, and which is well known. Two other contributions to the "Proceedings" from his pen were papers on "The Emission of Heat by Hot-water Pipes," and on "The Alexandra II. Bridge over the Neva."



From a photograph by Elliott and Fry.]

SIR WILLIAM ANDERSON, K.C.B., F.R.S.

THOMAS SUMMERSON.

WE regret to have to announce the death, at the advanced age of eighty-eight, of Mr. Thomas Summerson, of Darlington. Mr. Summerson had the unique distinction of being connected continuously with railway work from before the date of the opening of the Stockton and Darlington line till very shortly before his death, which took place on Tuesday, the 6th inst., at his residence, Haughton-le-Skerne, which had been his home for some forty years.

Mr. Summerson was born in April, 1810, at South Shields. He was from his earliest years endowed with a remarkable memory, and quite well remembered the holiday which he got from school in celebration of the victory of Waterloo, though he was only five years old when it occurred. As a boy he was very delicate, but in manhood he acquired such strength and endurance that it was no uncommon thing for him to walk fifty miles and upwards in one day, and he was noted on the Stockton and Darlington Railway for his activity and skill in leaping on and off trains when running at speed.

At the age of fourteen he was employed in hand drilling the stone blocks which were to be used for supporting the rails of the Stockton and Darlington Railway. For this he was paid 8d. per day, and was expected to drill twenty-four blocks for the 8d. The time fixed for the opening of the railway was the 27th September, 1825. Mr. Summerson was present at the opening, being at that time directly employed by the railway company. During the construction of the Stanhope and Tyne Railway he was employed on it as a labourer, and was present at the opening in 1834. The survey for the "Great North of England Railway," as it was first called, from Darlington to York, was made in 1836, and Mr. Summerson was employed on it under Mr. Storey, the engineer to the Stockton and Darlington Railway. When this gentleman was succeeded in this post by Mr. John Harris, the latter gave Mr. Summerson the post of permanent way inspector. This was in 1839. Mr. Harris contracted with the company to uphold and maintain the permanent way for ten years, and had also other important work in hand, especially in the construction of the Middlesbrough and Guisbrough Railway, and in these he was assisted by Mr. Summerson with great success, so much so that the latter was awarded a bonus of £1000, all of which, however, he subsequently lost in an unsuccessful speculation in patent brick manufacture.

In 1853 Mr. Harris took a lease of Hope Town Foundry, and Mr. Summerson was appointed manager, being in the course of time taken into partnership. A large trade was done in cast iron chairs and wheels. Mr. Summerson, in conjunction with Mr. Harris, introduced and patented a railway chair with a wood cushion under the rail, and also a special form of chilled cast iron wheel for chaldron wagons. Mr. Summerson, while in this position, also invented a new crossing, and patented a hot-air cupola for economising fuel. In 1869 he acquired the Albert Hill Foundry, and commenced business on his own account. This business, under the title of Thomas Summerson and Sons, is still in existence, and has a wide reputation for switches and crossings, the principal articles manufactured. Mr. Summerson is credited with first having introduced wooden sleepers in place of stone blocks for railway work.

WEEKLY PAYS ON CLYDESIDE.

CONFERENCES on the subject of weekly payments of wages have for some time past been held between representatives of the federated trades on Clydeside and a committee appointed to represent the Clyde Engineering and Shipbuilding employers, with the result that a decision has at last been come to, to grant the repeated request of the workmen, and give the system a trial. Although the introduction of weekly pays will entail much more work on the clerical staffs of the employers, the main objection of the latter all along has been that the time wilfully lost by workmen under the weekly pay system will be greater than at present, with the pays occurring fortnightly. This opinion they based upon actual experience elsewhere, but the representatives of the men contend that they have equally good justification for their belief that the shorter payments will tend to decrease the time lost. Experience, however, will show. The preparations necessary for this change in existing arrangements will not admit of its initiation before the spring, but once started the trial will extend over twelve months. At the end of that period, should the system not have worked satisfactorily, the employers will be at liberty to revert to the old arrangement. The permanency or otherwise of what ought to be a boon to workmen and their families will thus depend to a very large extent on the conduct of the men themselves. The matter has given rise to a good deal of discussion in centres of industry on Clydeside, and amongst the working classes themselves there is a very general sense of satisfaction. They believe the boon to be so considerable and general that few of their number will be found to be regardless about forfeiting the confidence of their employers as well as their own self-respect. The fortnightly system of payment, they aver, engenders a spirit of recklessness.

THE Victorian Railway Commissioner has decided to recommend the construction of a line of railway to Mildura, at an estimated cost of £301,400.

THE working of gas engines by acetylene gas will form the subject of interesting experiments which Professor Burstall proposes to carry out at the Mason College, Birmingham.

LETTERS TO THE EDITOR.

(We do not hold ourselves responsible for the opinions of our correspondents.)

COLLISION MATS.

SIR,—The provision of a serviceable and efficient collision mat is admitted to be one of the most important subjects in connection with life-saving at sea, and yet the attention paid to it by the Admiralty and the owners of merchant vessels is, at the best, spasmodic, and little or no determined effort is made to provide a mat which will answer all the purposes for which it was intended. The responsibility of the Admiralty and the owners of merchant and passenger vessels in this particular is, without doubt, very great, and yet at present we have no proper attention given to the question, which only crops up periodically, such as after the loss of a large vessel by collision or otherwise. It has been suggested by those interested in the question that the Admiralty officials, or those of the Board of Trade, should put their heads together and endeavour to discover by means of experiments, an efficient and thoroughly useful mat, which in case of emergency would answer the purpose for which it was intended. These could be conducted with the mats at present in use, and others made from the best specifications lodged at the Patent-office in Chancery-lane. It is alleged that there is not one in use at the present time which does not drift away with the tide when an effort was made to use it, instead of fixing itself over the hole in the injured ship. By conducting these experiments nothing would be lost, and much might be gained. The money spent would not be wasted, and its expenditure might result in many hundreds of valuable lives and vessels being saved.

In connection with these experiments it has been proposed that a competition might be conducted at the Agricultural Hall at the time of the Military Tournament, and prizes given for the most practical and workable ideas. But, in any case, if the Admiralty or Board of Trade invited inventors to submit ideas, out of the bulk sent in a really good and serviceable collision mat would perhaps be evolved.

About a quarter of a century ago the Vanguard was rammed in the Irish Sea, and sent to the bottom. But, be it borne in mind, she took one and a-half hours to fill with water, and it was never demonstrated that a collision mat would not have saved her. From that time right up to the present day no efficient collision mat has been devised. Yet during the last fifteen years something like one hundred specifications have been lodged at the Patent-office, and since 1883 thirty-six patents have actually been granted, but none of the inventors appear to have received much encouragement to continue submitting plans. Very few collision mats now in use bear the name of any particular inventor, for in the mercantile marine the mats used are, for the most part, designed by somebody in the firm owning the vessel. The same policy is adopted by the Admiralty, but very few of the mats in use at present are reliable, and none have proved themselves so at the supreme moment, as has been demonstrated by many recent collisions and sinking of vessels.

Mr. H. G. Tennant, M.P., the member for Berwickshire, who has always taken great interest in all that concerns domestic legislation for a protection of life and limb, recently asked in Parliament if the attention of the First Lord of the Admiralty had been drawn to a new method of fixing collision mats invented by Mr. Charles Mackintosh, and whether, in view of the large loss of life occasioned by recent collisions, he would consider the advisability of directing a scientific test or inquiry into Mr. Mackintosh's methods. Mr. Goschen, in reply, said that no representations had been made to the Admiralty on the subject, but that if any were made they would be carefully considered.

Whether Mr. Mackintosh has laid his specifications before the Board of Admiralty or not, there is no doubt that the Navy is in want of a good mat, and if this one is as good as experts claim it to be, influence should be brought to bear to induce the authorities of Whitehall to look into the affair, and it might be the means of providing a mat which would effectually do away with any chance of another Victoria disaster taking place.

Why could not a few of the most prominent inventors have a meeting and talk the matter over in a private conference? Between them something trustworthy could surely be thought out. At present in the Patent-office there are many excellent plans, including those of Captain G. A. F. W. Wilson, R.N., of Victoria, and of Colonel H. B. Hanna, Indian Staff Corps (retired), whose ingenious arrangements for preventing ships from sinking must be known, although little notice has been taken of them. Colonel Hanna's plan was to have vessels built with double sides and bottoms, and between this inner and outer skin of the ship to have rolls of matting, which, in case of collision, and both inner and outer skin being penetrated, the mat could be unrolled and allowed to fall over the hole made. The gallant Colonel might have been more explicit in describing his ingenious arrangement, especially as to the means for controlling the mat in order to bring it into the position required, as it appears that the rush of water would almost certainly prevent its being brought over the injured part. Again, the plates of the outer skin, when torn by the collision, would be forced against the inner one, and thus effectually prevent the mat from falling over the hole.

Captain Wilson's idea provides in a way for the drawing of the mat over the fracture, but his idea will bear improvement. Like other specifications, this one lies in Chancery-lane merely for the perusal of future inventors. Our American cousins, too, are not behindhand in submitting plans for collision mats, and some very good specifications have come from the United States. Mr. D. Jarves, a gentleman from Michigan, has submitted a scheme which is well worthy of mention. In his specification he advocates the use of the rectangular piece of heavy sail cloth, or heavy rubber cloth, one end of which is secured to a heavy roller, and the other end of the mat is provided with hooks or clamps, by which it could be securely fixed into the rail of the vessel. The end of the mat with a heavy roller attached is intended to be let down into the water, the heavy roller being the means by which the mat would be forced down against the inflow of water. This idea has been adopted by a few shipowners, but even with this method, should there be any sea running, as in the case of the Elbe, it seems almost an impossibility to get it fixed over the injured part of the vessel. The necessary something to pull it over the hole is missing. Other inventors have suggested filling the cavity caused by the collision with sponges or air bags, but their plans are not very practicable, and not likely to excite much attention. The latest invention would appear to be the work of Mr. C. Mackintosh, the inventor whom Mr. Tennant referred to in the House of Commons recently. As his specification appears to have excited the attention of naval experts and others, it is worth referring to a little more in detail. This invention is declared to be the most practical one which has been submitted for some time, for, according to one authority, a drilled crew of the Royal Navy would be able to rush this mat over a fracture such as the Victoria sustained, in sixty seconds. Mr. Mackintosh proposes to surround his vessel from stem to stern with a line made up of sections of suitable lengths connected together with snap hooks. This line is lashed to the side and held securely in position by small lines at convenient distances, which are connected with catches on board. Fore and aft, port and starboard, are placed the guiding arms, these being wrought iron or steel tubes fixed on pivots a little above the water-line, and extending upwards on an incline until in contact with the line. The ends of these guiding arms are fitted with revolving pulleys through which the line is passed. The mat is stowed amidships in a convenient place, suspended from the top bar, and rolled upon a flexible roller encircled in a half tube which prevents it when unrolling from being forced in by the pressure, and is fixed, so that when the mat is rolled out to its extreme length the half tube, falling off the flexible roller, will conform to any inequality in the shape of the hull. When the alarm is given the mat is suspended from the rail above the injured part, the line surrounding the ship disconnected at the nearest snap hook, and the ends connected with lines attached to a roller suspended from the flexible roller called the bottom bar. The line is set free from the guiding arms on this side, but left connected and passing through the pulleys of those on the other side. The officer in command then simply presses an electric button, when the whole of the line in use from stem to stern with the guiding arms, even if fitted on the largest liner, cruiser, or battleship afloat, will, as it were, almost instantly plunge into the sea, and the line swing underneath the keel from the bottom bar of the mat to the pulleys of the guiding arms now down, and from these continued up the side of the vessel and connected on board with high-speed capstans which quickly haul the slack in and the mat over the fracture. Experts assert, too, that had this invention been in use at the time of the ramming of the Victoria by the Camperdown, the probability is that the Victoria would have been saved to us, and a great loss of life prevented. The Bourgoyne and Elbe, too, might have yet been afloat had such a collision mat been in use. Mr. Mackintosh has paid great attention to the question of speedily getting the mat into position, and of holding it over the fractured part of a vessel when it gets there.

There is also the specification of Mr. Holmes, a shipbuilder, well worth consideration, as also those of one or two engineers, and of several gentlemen in private capacities. Space will not permit entering into the details of these, but a reference to an article on the collision mat service by Commander—now Captain—G. F. King Hall, in command of the Narcissus, published some time ago in the *Journal* of the United Service Institution, will not be out of place here. The following is an extract from the article. He says:—"As an officer who has served some years as first lieutenant and commander, I am convinced that the present collision mat, 12 by 12, is of little practical use, and those who know the difficulty of accurately placing it over a fracture will agree with me that if a ship be rammed, and a serious hole made in her, by the time the mat was placed she would be full of water. I would propose that mats of No. 1 canvas should be used when at sea, kept permanently rolled and stopped up on the outside of the ship ready for immediate use, with a head of 40ft. long, and arranged so that each could be slipped along a certain space. In most of our large ironclads four of these mats on each side would be sufficient, and would cover a space of about 160ft. These mats should be always kept on at sea, so that if a vessel be rammed, all that is required would be a couple of straps, when the mat could be unrolled over the fracture, with the bottom lines continued upon the other side. This could be done in about two minutes from the time of the collision, and I am convinced that if the Victoria had been provided with such an arrangement she would have been saved."

Each inventor of a new collision mat claims to have made improvements upon the last specification taken out, which, of course, is only to be expected. But the whole matter apparently ends when the patent is granted, and except for a paragraph or two in the newspapers nothing further is heard of the matter. Some decisive step should be taken to oblige vessels by law to carry a collision mat which at the supreme moment would not fail to be of use. Year after year specifications are lodged at the Patent-office, and what is the result? Shipping companies and owners of large passenger vessels take no notice of them, do not trouble whether they are an improvement upon that they are using. Every now and then an agonised wail of despair is heard when news comes to hand that another great vessel and hundreds of lives have been lost. A good serviceable collision mat might have saved both vessel and lives. Legislation can do a great deal towards reforming this state of affairs, and the member who has courage enough to bring the matter before Parliament, and persistently hammer into them the necessity there is for a trustworthy collision mat, both in the mercantile and Royal Navies, will earn the everlasting gratitude of the whole of the seafaring population of Great Britain, and thousands upon thousands whose business causes them to "go down to the sea in ships." Mr. Tennant has led the way. Why should not other members such as Sir Ashmead-Bartlett, Admiral Field, Lord Charles Beresford, and others, follow the subject up? Captain G. F. King Hall, in command of the Narcissus, China Station, is confident that his arrangement would have saved the Vanguard, and experts of higher authority express the same opinion in regard to Mr. Mackintosh's arrangement, so far as the ill-fated Victoria, the Elbe, and Burgoyne were concerned. Surely the opinions of these men on a subject so important to the naval and mercantile marine ought to receive more serious attention.

London, December 15th. INTERESTED.

HIGH-SPEED AIR PUMPS.

SIR,—Several interesting letters having appeared in your columns under the heading of "High-speed Air Pumps," I feel that, as the initiator of this correspondence, I am called upon to make some reply to the various communications, in so far as they traverse the statements contained in my letter published in your issue of the 4th November.

With a view to clearing the ground and preventing possible misapprehensions calculated to incite commercial controversy rather than technical discussion, I may state that, although I have the privilege of numbering Mr. Edwards amongst my professional friends, I have no business connection whatever with his air pump, nor do I hold any gratuitous brief in his interests. Mr. Edwards' air pump has attracted my attention, and evoked my admiration, simply because it appears to me to be one of those comparatively rare instances of beautifully simple and intelligent design in strict compliance with natural laws.

Mr. Dunlop illustrates a pump designed by Mr. Charles Brown, which has neither foot nor bucket valves, and he describes it by means of a compilation of extracts from my letter, presumably with the object of establishing the identity of the Brown and Edwards designs. Their identity is, however, more apparent than real, as would speedily be discovered if an attempt were made to demonstrate it by running the two pumps under the same conditions, even at a moderate speed.

The Brown pump is designed in defiance of the laws of inertia, the fact that the air cannot find egress through a drowned port, and the law by which fluids in motion flow along the lines of least resistance.

In the illustration the water level is shown right up against the bucket. This is apt to lead the casual reader to overlook the shock due to the impact of the flat-bottomed bucket with the water, but it has the disadvantage of indicating that, whilst the bucket is displacing water, it is also covering up the port of entry into the barrel, and therefore the water must perforce pass up into the chamber, whence it descends when the bucket uncovers the port, and effectually closes any passage which might otherwise have accidentally existed for the egress of the air.

In actual practice the water level would have to be much lower than shown, and there would be considerable shock at the point of impact, whilst the air would still be locked out owing to the disposition and form of the channels and the port.

Personally, I cannot conceive that Mr. Edwards could have any ambition to pose as the inventor of the Brown air pump.

"Superintending Engineer's" letter, drawing attention to the fact that in the common air pump the water is forced into the barrel, is scarcely to the point, inasmuch as the subject under discussion is a type of pump specially designed to embody the advantageous features of the common pump whilst eliminating its most objectionable features, viz., foot and bucket valves.

In my letter I only emphasised the point of the positive propulsion of the water into the barrel at the required velocity, because it was an essential point of difference between the United States navy and the Edwards pumps. His remarks concerning foot valves are undeniably correct, and clearly prove the desirability of dispensing with them.

Mr. Lupton illustrates and describes an interesting form of horizontal suction-valveless air pump applied to a jet condenser, the pump really consisting of two single-acting pumps placed end to end with a common inlet. This pump is scarcely relevant to the subject of "High-speed Air Pumps," and, in my opinion, one of its chief defects lies in the fact that it is horizontal, and, amongst other consequent disadvantages, it carries no water seal on the bucket to prevent leakage through the opening, which will inevitably exist on the top side of the bucket.

The shield over the upper ports, which would otherwise be the natural inlet for air, is apparently for the purpose of enabling a pressure to be exerted upon the water to expedite its passage into the barrel. Mr. Lupton states that this pump is running at ninety revolutions per minute, and maintaining a 25in. vacuum.

I think I am right in saying that Mr. Edwards has produced a 28in. vacuum at 500 revolutions per minute with an average barometer pressure.

Mr. Lupton appears to have misunderstood the nature of the conditions which I stated as being essential to maximum efficiency. There are two ways of equalising the pressures in the condenser and pump, the one being to bring the pressure in the pump up to the condenser pressure, and the other being to bring the condenser pressure down to the pump pressure. The latter is the essential to which I referred.

"Antiquarian's" letter is of considerable historical interest, and I may state that I was surprised to learn that, so far back as 1845, Mr. Bodmer had conceived the idea of a valveless air pump. It is another evidence of the clear perception and inventive genius which has earned for Mr. Bodmer the admiration of the present generation of engineers.

The very clear comparative sectional sketches of the Bodmer and Edwards pumps which "Antiquarian" has embodied in his valuable communication illustrate how very narrow is the dividing line between partial and complete success, and accentuate the necessity for strict compliance with those natural laws which no designer can ever disregard with impunity.

Although the similarity of the two designs is apparently complete, there are differences in the forms and relative positions of the channels and ports, from which I venture to predict that the Edwards pump would necessarily perform its proper functions more completely and efficiently than that designed by Mr. Bodmer.

In the latter a large proportion of the displaced water would pass back into the condenser, the water channel and ports embrace only a small portion of the circumference of the barrel, and therefore power must be wasted in violently projecting water radially against the walls of the casting.

In my opinion, the undeniable success of the Edwards pump is due to the thoughtful and intelligent care with which every detail has been designed, in deference to the laws of inertia and fluid motion, and in appreciation of the necessity for affording free egress for the air, eliminating all pressure-raising obstructions between the condenser and pump barrel, and reducing clearance to a minimum. By these means it has been rendered practicable to run the pump successfully at very high speeds, and to reduce the condenser pressure to a point closely corresponding to that due to the temperature. I understand that Mr. Edwards has run one of his jet condenser pumps at 200 revolutions per minute, and this speed can be considerably exceeded.

When I wrote my first letter it was far from my intention to enter upon a long newspaper controversy regarding the claims of rival inventors. In paying my humble tribute to Mr. Edwards' skilful design, I had no wish to invidiously stultify the valuable achievements of other workers in the same field.

The correspondence has brought forward the names of several engineers who have aided the progress of this branch of engineering by their pioneer footsteps in the paths of reason and common sense, and to whom all praise is therefore due; but I have not yet discovered any adequate reason for withdrawing my statement to the effect that "until Mr. Fred. Edwards invented his pump, no really successful attempt had been made to devise an air pump embodying those features which are essential to the realisation of the ideal conditions."

The Glen, Petersham, Surrey, D. A. BREMNER.
December 6th.

SIR,—As a point seems to be made of the cone on the bottom of the bucket of the Edwards air pump, permit me to direct attention to the circumstance that tapering off the plunger to diminish shock originated, so far as I am aware, with Mr. Allen, and was shown with Mr. Allen's engine in the 1862 Exhibition. It has since been extensively used by continental firms.

December 7th. P. R.

THE INSTITUTION OF CIVIL ENGINEERS' EXAMINATIONS.

SIR,—In reply to the remarks of "Laudator Temporis Acti," I referred to Stoney because I observe that his work—of which the last edition is not at all thirty years old—is frequently referred to, in your columns and elsewhere, as if it were a well-known, intelligible, practical authority. I am surprised at objections on the score of antiquity coming from the pen of "Laudator Temporis Acti." One would rather expect him to be satisfied that if a thing was standard engineering knowledge *consule Planco* it ought to be so now. I beg leave, to save your space, to refer "Laudator Temporis Acti" to the venerable authority of Stoney for explanations of the terms "modulus of elasticity" and "plasticity." If Stoney is not sufficiently common engineering property, he will find them in Molesworth. "Chambers' Encyclopedia"—not to mention the "Proceedings" Institution of Civil Engineers—draws no distinction between "modulus" and "coefficient" of elasticity. My "Chambers" is an oldish one; perhaps "Laudator Temporis Acti" is more "up" than I in the modern usage of the terms. I made no reference to technical schools. I never was at one myself, nor did I ever attend any classes at any college on engineering subjects—unless attendance at my own lectures be counted. I think most of my earlier book knowledge of engineering was derived from your own columns; being dissatisfied with that, I went in for learning by the standard method of apprenticeship and practice. "Laudator Temporis Acti" fails to show that the examiners did not fairly test what they were expected to test, viz., the candidate's knowledge of "those branches of physical science which form the basis of engineering, apart from any standard of practical engineering knowledge." It is, of course, notorious that the training referred to by "Assoc. M.I.C.E." would not be likely to give the training the Council intended to test. What, may I ask, would be the value of my opinion on an examination paper on German grammar, considering that I never learnt any to speak of, and have forgotten most of that?

With regard to the solution of the case of a long column, "Laudator Temporis Acti" forgets that the load $W = \pi/4c$ on the column bent cl will seriously increase the compressive stress on one side above that due to the bending. Also he did not investigate—as Euler did—the point whether the equilibrium of the column as regards bending is stable or unstable.

I hardly think it necessary to cumber your columns with explanations of the terms "harmonic motion" and "natural period of vibration." If "Laudator Temporis Acti" would be pleased to attend some of the elementary lectures of the Professor of Natural Philosophy here—the Queen's College is not a technical school—he could get a little of the training the examiners, at the desire of the Council, wished to test, and would get these matters made quite clear very easily. For the solution he asks for I see little gain in your inserting, in this letter, one, which I have no reason to suppose he will understand, of a question of whose meaning he does not seem to be clear, referring to matters with which he seems to be very slightly acquainted. Its intimate connection with such things as the troubles mentioned in your article on "High-tension Trunk Mains," their causes, prevention, and cure,

is sufficient evidence of its practical value. "Laudator Temporis Acti," and some other people I have heard of, seem not to bear regularly in mind that the persons who have charge of permanent way, bridges, culverts, quays, canal banks and locks, or water-works, are not the only engineers in the world, and occasionally forget that Sir B. Baker once remarked, and quoted instances to prove it, that even in erecting a bridge he had seen able, practical men commit blunders which a mere student in engineering would as soon contemplate as manslaughter. The same is true *vice versâ*; but you will not avoid the blunders by omitting the training of the student.

I forgot to assist "Laudator Temporis Acti" by mentioning that Molesworth gives a table of the values of the transverse strength of various materials, with a note explaining the term. I was glad to see his remark about bench marks on trees. The fact that exogenous trees do not grow so as to raise marks on them higher from the ground seems not to be well known.

Queen's College, Belfast, December 6th. MAURICE F. FITZGERALD.

SIR,—I have read with interest the letters which have appeared in your paper lately on this subject. I shall be glad if you will allow me, not to defend the action of the Council, who need no such support, but to express what I believe to be the general feeling of the corporate members with regard to the new admission rules.

To belong to the Institution is a sort of engineering hall mark; but it is a matter of common knowledge that of late years a good many have been admitted who really had no claim for such distinction. Such a state of things, if continued, would speedily have reduced the value of the Institution's diploma to zero, and, presumably to check this, the examinations have been established.

On comparing the old and new bye-laws, it will be seen that the examination is not in lieu of, but additional to the old qualification, and that while passing the examination will, in most cases, be a necessary adjunct of admission, that by itself will not qualify a candidate. As, therefore, examination is only a portion of what is required, I entirely fail to see why the Council should issue a certificate, as suggested by "One who has Passed." It would be a matter of interest to know what "One who has Passed" would do with the certificate when he got it; framed and hung in his office, it would no doubt be ornamental, but probably of less value in impressing clients than some photographs of works executed by him in the past.

One good point in the examinations—not, I think, touched on in your columns—is the relief they will afford to members who are asked to support a candidate of whose qualifications they may be a little doubtful, but whom from friendship or other reasons they hesitate to offend. To these the examination, by relieving them of much responsibility, comes as a blessing. Examination has been called "justification by faith," and future corporate members of the Institution of Civil Engineers will have to be justified, not only by faith, but by works also.

December 10th. E. R. DYMOND.

THE VALIDITY OF JAPANESE PATENTS.

SIR,—My attention has been drawn to a letter of "Your Recent Special Commissioner" in Japan, in your issue of November 18th, in which your agent roundly states that no valid patents have been issued in Japan to foreigners, and intimating that all the very numerous patents so far issued to foreigners are bogus, and so much waste paper, and that it is no use paying money to patent agents to take out patents in Japan "until the Japanese patent law is on a proper footing with regard to foreigners." Now, as my firm has obtained a very large number of Japanese patents for various clients in England, her Colonies, America, and the continent of Europe, I write to inform you that these patents have been obtained through a barrister of the Supreme Court, and of the very highest eminence, who was recommended to us as the most eminent authority in Japan by the very Consuls whom he refers us to in the letter for information in support of his assertions. That the statement of your agent as regards the law being different in regard to foreigners is an entire mistake, as the law now makes no distinction as regards patents between British subjects and the subjects of several other countries and Japan. We have ourselves carried a patent case up to the Supreme Court of the empire, in which a foreigner was the applicant, and the Supreme Court decided that the question of whether the inventor was a foreigner and resident abroad, made no difference whatever in the granting or holding of a patent.

In this action we had the kind assistance of the American Ambassador, and we believe the English and German likewise. Furthermore a treaty was made between the German Government and Japan, granting to German citizens exactly the same rights as regards patents in Japan that Japanese subjects have, and this treaty has been definitely extended to Great Britain and some other countries. The letter of your agent is simply vague generalities of what is his "belief;" he shelters himself behind a *nom de plume*, and we challenge him to produce any proof of the truth of his assertions—or, more strictly speaking, his insinuations—against the Japanese Patent-office and the Japanese and English patent agents obtaining these numerous patents for foreigners.

WM. P. THOMPSON,
Patent Agent, Liverpool, Manchester, Birmingham, and London.

Liverpool, November 26th.

[We insert Mr. Thompson's letter, although it approaches very nearly an advertisement. Mr. Thompson is under a complete misapprehension. Our Special Commissioner has never said that patents are not granted in Japan to foreigners, British or others. All he has done has been to express doubts as to their value. Until the patents have borne the test of litigation, and can be shown to protect the patentee against infringement, Mr. Thompson's opinion is perhaps not worth more than that of our Commissioner.—ED. E.]

OVERHEAD ELECTRIC CRANES.

SIR,—In your article, "Trade as It Is," you speak of extensions of works, and say that many overhead travelling cranes are being erected in them, especially those of the electric three-and-one motor type. Having recently purchased for our works extension a 10-ton overhead crane, I was led to investigate and institute a comparison between rope and electric-driven cranes. My decision was strongly in favour of the rope-driven crane. My object in writing you is to try and induce some of the advocates of electric cranes to tell us why these should be used before the rope-driven. I myself have failed to see anything to compensate for the large extra expenditure that they demand, and I am strongly of opinion that the whole thing is a fad.

The first cost has not only to cover the motor or motors on the crane, but a dynamo and its connecting conductors and switches. What advantage does one gain from their use? Is it speed in travelling? If so, I think 150ft. per minute quite fast enough for a 10-ton crane, and am quite satisfied with it.

There are some serious objections to overhead electric cranes. For instance, how long would such last in an ironfoundry?

Another defect is the difficulty one has in being able to lower or raise a short distance, say, a quarter or half an inch at a time. Anyone who has tried lowering an engine cylinder into its position, or putting a crank into its position, or other similar jobs, will appreciate the ability to lift or lower a weight in such a way that you can guide it into position. With the electric crane this is a question of hit or miss. The motor in starting takes some time to get its speed, and, after it does get its speed, it takes some time to stop. The momentum due to the high velocity of the motor is communicated in a lesser degree to the gearing, and from this arises the difficulty of raising and lowering weights for any short distances.

With the rope-driven crane this is easily done. The motions for raising and lowering are controlled by open and crossed belts or by clutches. In both cases the operator can accomplish his task of lowering, say, a crank into its bearings or any other work where a little manipulation or guidance is required.

I await with interest some discussion of the advantages of electric cranes. The question of the cost of working I leave aside, except to say that in an electric crane I am sure that it must be heavier than by rope.

Halifax, December 7th. HUGH CAMPBELL.

BRITISH AND AMERICAN MACHINE TOOLS.

SIR,—As one who has for many years worked both English and American tools, your correspondent's letter upon the above subject in your issue of the 9th inst., is to me particularly interesting, and I trust we may have the opinion of others upon this most interesting subject. Now, Sir, this is a very broad subject indeed, and probably, while our friend has found fine American machine tools of great value in the manufacture of interchangeable working parts for gas and oil engines, no doubt there are also many large firms in the cycle trade who, could they see their time over again, would steady themselves somewhat in the purchase of American novelties. Of course, no one will refuse to admit that we have received benefits in some direction from American tools, which as a rule are very pleasing to the eye, and also of very delicate construction; but, while we agree to this statement, we must not overlook the fact that there are more ways than one of viewing a subject of this kind.

I think the principal reason why the Americans have received such a harvest in this direction is simply because during the cycle boom, the demand for special tools was so great that it was utterly impossible for English manufacturers to supply quantities anything like equal to the demand. In fact, during the latter part of 1896 and the first quarter of 1897, the writer offered to place orders with Birmingham toolmakers to a total value of £3000, conditional as to date of delivery. The firms in question could not undertake to supply in time, the result being that I did not purchase American tools, but what we could not purchase from English stock we had made to our own specifications and drawings, the work being executed in various parts of this country. Referring to lathes and drilling machines, Messrs. Ward and Co., of Birmingham, supplied lathes, drills, shaper, and miller, in 1896, to the Aston Manor Technical School, and I being at that time demonstrator had an opportunity of using these tools, and I can assure you that had I to obtain my living by the piece, I should much prefer such machines as these for my own use. Then, there is the cutting-out press and the drawing press, used for cartridge and sheet-metal work, as made by Messrs. Taylor and Challen, of Birmingham, who also make any special automatic machinery used in the production of ammunition, &c. Some years ago, when ordering power presses from Messrs. Taylor and Challen, I saw in their works a broken power or drawing press, that had been supplied by America at an enormous cost. They were replacing this by one of their own make, and a sight of these two side by side was very impressive. I also remember some years back, when engaged in an umbrella manufactory, some machines were purchased from America for making umbrella ribs and stretchers. There were also machines in that works designed and made by an English workman. I saw both, the difference between the two being that the English machines were no trouble, while the American required very close attention, and much more overlooking.

I think, without taking up any more valuable space, I would observe that were your correspondent engaged for some time as works manager in a cycle works, where both English and American machinery were running, he would find that the so-called automatic American machines for general use, besides being very expensive in first cost, requires also a great amount of mechanical skill and attention, and, as a rule, will not produce anything like what is stated by the representatives who offer them for sale; or, in other words, give a certain number of workpeople simple machines and jigs to produce certain work, and let the machines and jigs be English make, and then place the result at the week's end by the side of the same work produced upon American tools at the same cost of labour. In my opinion, cycle makers could tell us something about this. As regards myself, I am, of course, only one of many, but my experience has been that if you purchase half-a-dozen machines to produce so much work per hour, you can generally think yourself lucky if you obtain half the results promised when you come to actual practice. I could give names and make of machines, and where they have worked in this city, and with what result, but this would serve no useful purpose.

Let English machine toolmakers get up good showy catalogues, and let their representatives produce glaring figures *re* production, and they have nothing to fear, only they must mind the figures are correct, as they will be much easier to get at than our American friends, after the cat is out.

Westfield-road, King's Heath, Birmingham, December 13th. R. B. HODGSON, A.M.I.M.E.

SIR,—With reference to Mr. Hugh Campbell's letter in your last week's issue on the above-mentioned subject, I should like to submit the following remarks:—

Mr. Campbell prefaces his letter by saying that he has no object in "puffing" American tools. This would hardly appear to be the case, considering the amount of trouble he has evidently taken in making himself acquainted with American machines, and, on the other hand, his apparent want of knowledge of the practice adopted in this country by the leading toolmakers.

Regarding his statement that British toolmakers "despise or affect to despise" their American competitors, the general opinion prevailing is, to my mind, that both the tools themselves and the methods employed are admirable.

Your correspondent mentions that boring and turning mills, or horizontal lathes, had not been made in this country until a couple of years ago, excepting by one Manchester firm. It may be interesting to him to hear that lathes of the type referred to were made by the firm with which I am connected nearly half a century ago, and, so far as can be ascertained, they were the first of the kind that had ever been constructed either here or elsewhere. Taking milling machines, this description of machine also was originally designed and constructed by the same inventor as the vertical lathe, some considerable time before such a machine had been made in America.

As regards planing machines, the cutting and returning speeds are entirely dependent on the nature of the material and the weight of the objects required to be dealt with. For instance, when planing armour plates, weighing 20 to 30 tons, would your correspondent suggest the cutting speed he mentions of 20ft., and a quick return of 80ft. per minute, for such work? Surely not. As to the broad feed, Mr. Campbell, who says, "you can't get it on a British plane," will be surprised to learn that my firm have been for nearly twenty years, and are now, constantly making planing machines with feeds varying from $\frac{3}{32}$in. up to as much as 1$\frac{1}{4}$in. broad, and this, according to Mr. Campbell, is considerably in excess of the broadest feed obtained by the American practice, which he gives as about 1in.

Respecting the prices for horizontal boring machines mentioned, I am not surprised at the figures given, as machine tools approximately answering the same specification, can be obtained at various prices, but the difference in design, workmanship, and quality of material of the higher-priced machine will almost invariably be found to outweigh the difference in the price. As to the time given by Mr. Campbell for boring and facing his cylinders, this, of course, we have no alternative but to accept. With regard to drilling machines, the arrangement of "movable" head was adopted by us years ago, but it is only of late that this plan has been favourably accepted by users. Taking Mr. Campbell's remarks about lathes—which, by the way, would appear to be the only British tools he can tolerate—we may say that the practice in this country to prevent the belt from slipping into the back gear is to cast a flange on the cone pulley, and this we consider is far preferable to the two projecting pieces of metal cast on the headstock which Mr. Campbell alludes to.

In conclusion, it would seem as though Mr. Campbell had, so far as the best British tools are concerned, been burying his head like the proverbial ostrich, not in the sand, however, but in Halifax.

If he will visit the principal engineering establishments in this country, say, for example, our leading marine and ordnance works, and the large Sheffield firms, he will there see machine tools of British design and manufacture, which certainly cannot be excelled, and, in our opinion, are not equalled by any machine tools produced in America or elsewhere, and I think he will come to the conclusion that the British toolmakers are quite wide awake, and are not living in a "Fool's Paradise."

Manchester, December 13th. BRITISH TOOLMAKER.

SIR,—Mr. Hugh Campbell, of Halifax, in a letter in your last issue makes a severe indictment againt British machine-tool makers, supported, to a large extent, by vague assertions. He makes some definite statements about planing machines, however, in regard to which we would ask your permission to make a few remarks, without any desire to discuss the general question.

He refers to the Sellers planes as made in this country—we adopted this system in 1872, and have continued to manufacture these machines up to the present time—and proceeds to criticise the speeds, gear, and feeds used in this country: (1) Mr. Campbell says, "No maker can offer 20ft. cutting speed and 80ft. return speed." We have for many years adopted as our standard a cutting speed of 22ft. per minute with a return speed of 3 to 1—a higher ratio of return speed is merely a question of arrangement—in our opinion 3 to 1 is quite high enough, especially for heavy machines. (2) No doubt our British toolmakers—at all events, the best of them—will feel complimented by Mr. Campbell's exaggerated description of the vocal effort necessary to make one's self heard when talking alongside a British-made machine. Perhaps he has been unfortunate in his choice of tools. Nothing more need be said on this point, except that we are not afraid to invite Mr. Campbell to prove his assertion alongside one of our make of Sellers' planes, fitted, by the way, with well-made cast gear, not cut gear. (3) Mr. Campbell is speaking about broad feeds without adequate knowlege of facts. Broad finishing feeds have been made in this country for years. We, for example, have a patent of our own—Robinson and Oldfield's patent—which we constantly fit to our machines. This apparatus gives feeds varying from $\frac{3}{32}$in. up to 1$\frac{1}{16}$in., in the smaller sizes of machines, and 1$\frac{1}{2}$in. or 2in. in the larger sizes.

So much for Mr. Campbell's statement that such feeds cannot be got on a British plane. Perhaps, after all, if all Mr. Campbell's arguments are equally reliable, the intelligence and enterprise of the average British toolmakers are not of such a very low order. Perhaps some other of your readers may care to enlighten Mr. Campbell on the subject of horizontal lathes—which, he says, were not made in this country until a couple of years ago—and other points in his letter.

SHARP, STEWART, AND CO., LIMITED.
(J. F. ROBINSON, Managing Director.)

Glasgow, December 13th.

SIR,—What about Mr. Hugh Campbell? He writes a long dissertation on the advantages of American over English tools. Does he write with the knowledge gained from actual use, or are his statements made on the information gained from American catalogues and the representation of travellers for American machinery merchants?

The only instance given by Mr. Campbell in his letter of his own experience of the superiority of an American tool over an English one seems to be based so far on an inferiority of price. He tells us that he wished to purchase a horizontal boring machine, but that he preferred an American machine at £240 f.o.b. New York, and which has not yet been delivered, over an English machine at £335, which he did not order, and, consequently, has no experience of.

How can he pose as an authority on the comparative merits of these two machines when he has not used either? Let Mr. Campbell work both machines for six months, and then give us the results of his wide experience. At present the opinions which he advances so confidently are based on the voluntary "guarantee" of an American maker.

In concluding his letter Mr. Campbell further alludes to the above case as exemplifying his general statement that American machines are not so high in price as English machines.

Before forming a general opinion on such a slender basis, it would be interesting to know whether the two machines were of the same capacity; for instance, some boring machines are made single and others duplex. Possibly Mr. Campbell is comparing an American single machine with an English duplex machine.

Your space is too valuable to trespass on now, by replying to Mr. Campbell's somewhat sweeping general remarks, but their value would be enhanced if he would throw a little more light on the above instance brought forward from his own experience.

December 12th. ANGLO SAXON.

SIR,—If Mr. Campbell does not know more about other tools than he does about horizontal lathes, he is not a valuable authority. There was a gigantic lathe of the kind in use twenty-five years ago at Woolwich Arsenal, for turning the base rings of revolving turrets. Very fine lathes of the kind have been made in this country for years. There are two at the Erith Ironworks, for instance.

December 14th. A FITTER.

MODERN CHINA, FROM AN ENGINEER'S POINT OF VIEW: SHANGHAI AS AN ENGINEERING CENTRE.

SIR,—Will you kindly allow me to correct a slight inaccuracy in your esteemed Special Commissioner's letter on the above subject, published in your issue of August 19th last?

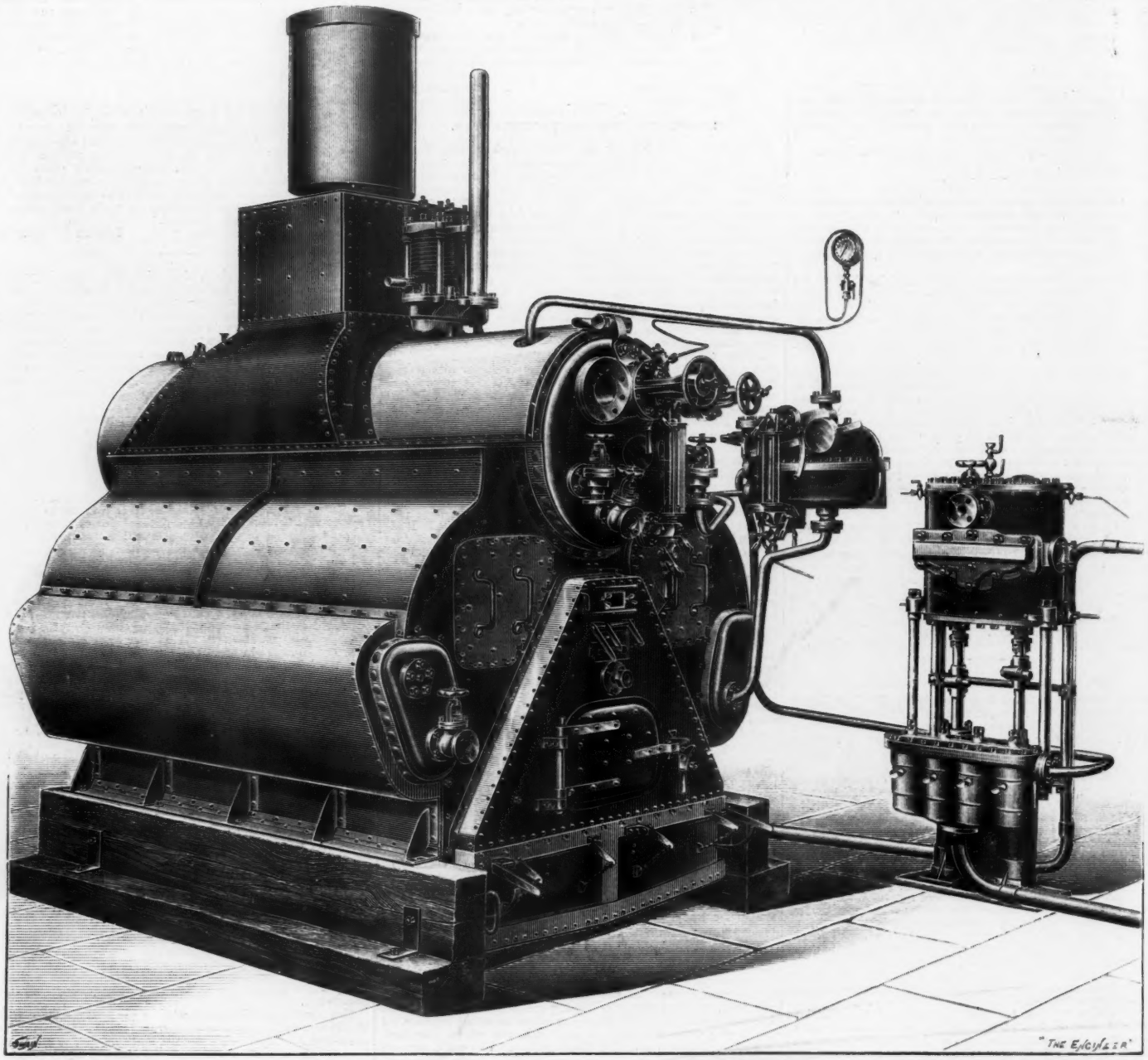
After pointing out that Shanghai is blessed with an energetic and extremely efficient Municipal Council, he goes on to say, "The street drainage is all open, and this, on account of its suitability, is, or will be, the general practice with big towns in 'The Far East.'" With reference to this statement, there are certainly towns in the Far East which have open drainage; but, so far as Shanghai is concerned, the drainage is entirely on the underground system.

Shanghai, China, November 17th. CHARLES MAYNE.

[We acknowledge the accuracy of Mr. Mayne's correction. The mistake was due to the fact that, although the article in question was practically completed in Shanghai, our Special Commissioner took it with him to Singapore. At that place his despatch box was stolen; and although he eventually recovered some of the papers, several sheets of his article on "Shanghai" were missing. He consequently had to re-write much of the article in question a long time after he had left that place, and in error he mentioned the Shanghai drainage as being on the open system, whereas his reference should have been to Singapore.—ED. E.]

WATER-TUBE BOILER FOR FIRST-CLASS TORPEDO BOATS

MR. A. G. MUMFORD, COLCHESTER, ENGINEER



MUMFORD'S WATER-TUBE BOILER.

THE special type of water-tube boiler designed and constructed by Mr. A. G. Mumford, of Colchester, for the first-class torpedo boats Nos. 63 and 64, differs in several points from the boilers made by the same firm for the Salamander, and illustrated by us on December 3rd, 1897. The main reason for the alteration in design was to accommodate the boiler to the smaller space allowed in the torpedo boats and the high efficiency required. An exterior view of the boiler is engraved above. The entire space occupied is—length, 9ft.; breadth, 7ft.; and height, 6ft. The heating surface is 850 square feet, and the grate area is 22 square feet. It was designed for 400 indicated horse-power, but the results of the official evaporation trials proved that far greater power could be developed. Burning 25 lb. of coal, an evaporation of 9·88 lb. of water per pound of coal, from feed-water at 58 deg. was obtained; burning 50 lb., the evaporation was 9·05; 75 lb., it was 7·4; and 100 lb., 6·317, all from feed-water at a temperature of 58 deg. These figures are unquestionably very good. Special attention has been given in this particular boiler to the reduction of the gases to a very low temperature, and by an ingenious arrangement this has been so far secured that the temperature at the base of the funnel never became excessive on the three-hours' trials above recorded. It is unnecessary to add that the boilers are fitted with Messrs. Mumford and Anthony's patent feed apparatus, which will be found fully described in connection with the Salamander's boilers.

AN ELECTRICALLY-DRIVEN ENGINEERING WORKS.

MESSRS. KENDALL AND GENT, machine tool makers, Manchester, have erected entirely new works, which have been specially designed and laid down to be driven and lighted throughout by electricity. Recently we had an opportunity of visiting these new works, and as they afford an interesting illustration of the progress that is now being made in the development of electric driving and its applicability to engineering works on a large scale, we publish on page 591 engravings showing the general arrangement of the main shops, fully equipped with plant and tools, all exclusively driven by electric motors. Our illustration, Fig. 1, shows a general view of the works taken from a gallery immediately in front of the manager's office, and opposite one of the main bays devoted to the heavier machines. It shows also to some extent the side galleries, which form an excellent second-floor for light machines. Fig. 2, which is taken from the ground-floor, shows the bay devoted to the lighter class of tools, with a partial view to the left of the adjoining bay under the gallery, with tools for preparing the work for machines to be erected in the section of which the photograph has been taken.

In laying out their new works Messrs. Kendall and Gent have been exceptionally fortunate, not only in securing a site immediately adjoining the Belle Vue Station of the Great Central and Midland Railway Companies, but in having a perfectly free and open space upon which to lay out their various shops on modern lines. The whole of the works designed by the firm have not yet been completed, provision having been made for considerable extension. At present the works consist principally of a lofty main building, devoted to the erecting and fitting shops, about 300ft. long by 150ft. wide, so arranged as to be well lighted from the roof and sides, and which has been finished and fully equipped with plant and tools. This building is divided into four main bays. The two centre bays are served by electrically-driven cranes—one of ten, and the other of twenty tons—traversing the whole length and covering all the heavy tools, as well as serving the loading and unloading department when required. The two other bays on either side, though open to the general works, form really a couple of two-storeyed buildings. The ground floor is occupied by machines serving the main working bays. The floor or gallery above is supported on steel girders of uniform section and pitch, so arranged as to afford suitable supports for the main shafts and all the driving apparatus, which are carried by specially designed hangers, arranged to clip on to the steel girders, and these, being of uniform section throughout, allow the hangers to be readily changed to any position as required, the advantage of which is obvious in fixing or re-arranging the position of machine tools. The main shaft bearings, as well as all the countershaft bearings, are self-lubricating, thus reducing the loss by friction to a minimum, and are adjustable for perfect and rapid alignment in any direction. The main shaft bearings, it may be further added, are so constructed that any section of the shaft with its pulleys can be detached and immediately lowered to the ground without threading through the bearings, which is a necessity in ordinary practice.

The driving throughout is electrical, the power being generated in a central station and distributed to the main shafts and cranes by motors, whilst it also serves for the lighting of the shops and offices. The generating station consists of two three-crank high-speed compound engines, which, running at 480 revolutions per minute with a boiler pressure of 160 lb., give an output of 100-horse power each, and are arranged to run independently or in parallel, so that either engine can be used for motors or for lighting as may be desired, or collectively when found necessary. The voltage of the installation is 230, and the distribution of the power throughout the works is mainly by motors of 20-horse power, driving groups of machines, each group being driven from a main shaft with a motor in the centre. This enables different types of machines to be driven in sections, so that the planing machines, boring machines, lathes, &c., can be operated independently as occasion requires. Another very useful arrangement is, that on every one of the main pillars in the centre of the works provision has been made for taking off 20-horse power, so that motors can be used for portable machines. It may be here added that the experience so far gained by Messrs. Kendall and Gent, although perhaps not yet of sufficient duration to be in all respects absolutely conclusive, points to the advantage of driving in groups rather than by separate motors, a good illustration of this being given by one motor of 20-horse power, which is driving sixty machines. Owing to the exceptionally favourable circumstances under which the driving is arranged, the main shaft and countershaft for all these machines do not absorb over 5·8-horse power, whereas if an independent motor were attached to each machine, the power necessary to drive these sixty machines would under any circumstances be greatly increased, as the power required to drive the motors themselves is considerable. To each motor in the works is attached an ammeter, showing the power absorbed at any moment, and it has been extremely interesting to measure accurately the power required by the different groups, or even by single machines, as the above arrangement enables either one or any number of machines in each particular group to be tested. The records so far taken point conclusively to the advantage of a compact continuously-running works driving the machines in groups, as against motors for each machine. The statistics which up to the present have been tabulated from the above ammeter measurements are, however, not yet sufficiently complete to afford absolutely accurate data upon which to base a comparison of the cost of electricity with that of steam, but the results, it may be mentioned, have been entirely satisfactory, and taking into consideration all the circumstances, Messrs. Kendall and Gent are of opinion that

MESSRS. KENDALL AND GENT'S WORKS, MANCHESTER

(*For description see page 590*)

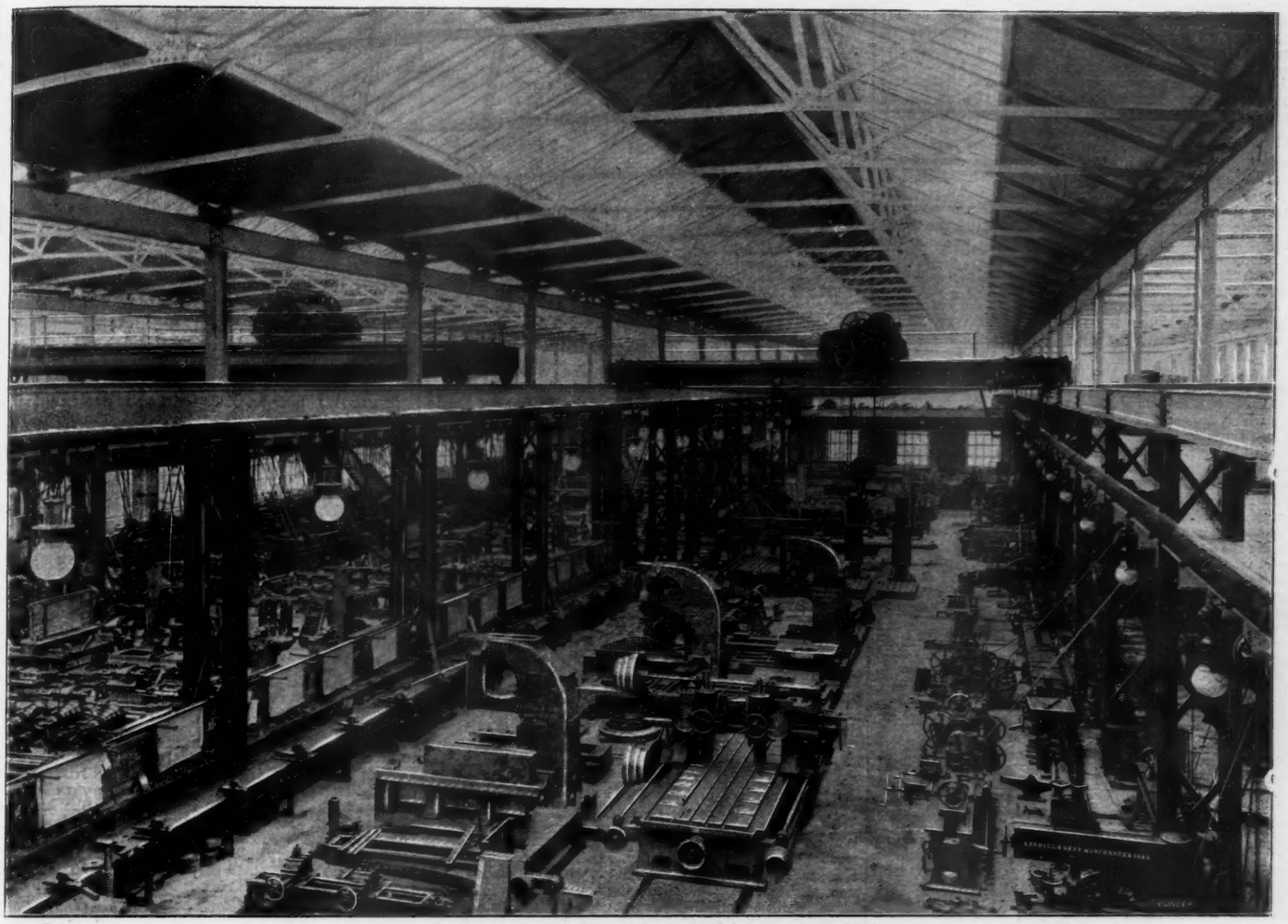


Fig. 1—GENERAL VIEW

Fig. 2—LIGHT TOOL BAY

the advantage is very decidedly in favour of electric driving. The cranes which cover the main shops have been supplied by Messrs. Vaughan and Son, of Gorton, and are of the three-motor type, the power being taken off the main cable from the generating station.

Our illustrations show pretty clearly the general arrangement of the several bays in the main shop, but it may be interesting to explain further that the organisation throughout has been designed to effect the greatest possible economy of time and labour in carrying on the various operations. For the reception, in the first place, of the raw material, every facility is provided by means of sidings, which are in direct communication with the adjoining main line of the Midland and Great Central Railways; whilst in the same way equal facility is provided for the discharge of finished machinery, the ends of the different shop bays leading out of the main building, and being also in direct communication with the railway, and served by the electric travelling cranes up to the point of loading into railway wagons. The organisation of the works is further designed so that the raw material entering the main building from the sidings is first delivered to the section fitted with the heavy boring and planing machines, and then advances in successive stages until it is again put on the railway siding as the finished product, all the operations proceeding in rotation, with no unnecessary loss of time or labour in twice traversing the same ground.

The lighting throughout the works is on the arc system, and as we believe this is the only installation, at any rate under similar conditions, where the arc system is employed throughout, one or two details will be of interest. The lamps, which are each of 1000 candle-power, are arranged in a zigzag form under the galleries, and are of the Stewart type, with holophane globes, giving a great diffusion of light, so that shadows are almost entirely eliminated. Along the centre of the works, over the fitters' benches, is a series of Brockie-Pell type lamps of 2000 candle-power. All through the works the lighting by this arrangement is most efficient, and operations can be carried on with equal comfort at night, or during the dark winter days.

Apart from the main block of buildings are situated the generating station, smithy, and pattern shops, and at right angles is a three-storeyed building forming a separate store for patterns. The offices form the frontage of the works to the railway immediately adjoining the Belle Vue Station, and are of suitable architectural design, presenting a substantial and somewhat imposing elevation. On the ground floor are the general offices for the works, occupying one side of the entrance, whilst the other is occupied by show-rooms supplied with electric motive power for enabling individual machines to be inspected in motion. The floors above are devoted to the private offices of the firm, the drawing and estimate offices, and other executive departments.

H.M.S. ARGONAUT.

THE trials of H.M.S. Argonaut, which commenced on the 25th ult., came to a satisfactory termination on the 8th inst. The engines of this ship are similar to those of H.M.S. Diadem, of which an illustration was given in a recent issue. The boilers are of the Belleville type, with economisers. The full working pressure is 200 lb. per square inch in the boilers, reduced to 250 lb. per square inch at the engines. The trials consisted of a series of two of thirty hours at 3600 indicated horse-power, one of thirty hours at 13,500 indicated horse-power, and one of eight hours at full power—18,000 indicated horse-power. The second thirty-hour trial at 3600 indicated horse-power was run to confirm the records obtained from the first trial. The following is a tabulated statement of the results of the trials:—

	First 30 hours at 3600-I.H.P.	Second 30 hours at 3600-I.H.P.	30 hours at 13,500-I.H.P.	8 hours at 18,000-I.H.P.
Draught of water:				
Forward	24ft. 3in.	24ft. 3in.	24ft. 3in.	24ft. 3in.
Aft	26ft. 3in.	26ft. 3in.	26ft. 3in.	26ft. 3in.
Speed, knots	12·5	13·3	19·5	20·8
Steam pressure in boilers, lb. per sq. in.	226	258	Various	293
Air pressure in stokeholds, in. of water	—	—	—	·21
Vacuum:				
Starboard	24·8	25·8	26·7	25·9
Port	25·4	26·2	26·5	25·4
Revolutions per minute:				
Starboard	74·4	75·5	115·7	128·8
Port	74·8	76·3	116·3	128·0
Mean I.H.P.:				
High, starboard	585	613	2169	2891
High, port	563	570	2138	2869
Intermediate, starboard	470	527	1684	2413
Intermediate, port	466	586	1769	2510
Forward, low, starboard	413	379	1482	1988
Forward, low, port	385	381	1398	1921
Aft, low, starboard	444	402	1683	2319
Aft, low, port	425	356	1488	1983
Total I.H.P.	3756	3815	13,815	18,894
Consumption of coal, lb. per I.H.P.	2·13	2·02	1·6	1·62

Throughout the trials hand-picked Welsh coal was used. Experimental trials were made throughout the series, which showed the evaporation in pounds of water per pound of coal to vary from 10 at the low power to 11·2 at full power. At no portion of the trials was there the slightest difficulty, and the Fairfield Company is to be congratulated on the successful results of the trials of this powerful addition to the Royal Navy.

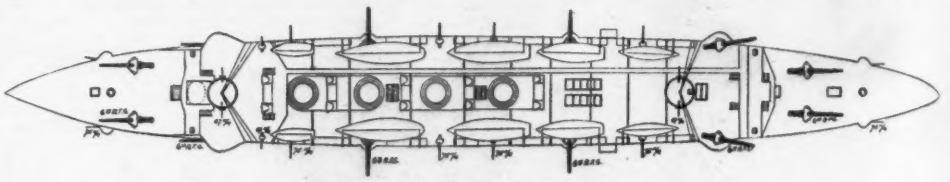
ROYAL INSTITUTION.—The following are the lecture arrangements at the Royal Institution before Easter:—Sir Robert Ball, six lectures (adapted to young people) on "Astronomy;" Professor E. E. Ray Lankester, ten lectures on "The Morphology of the Mollusca;" Mr. A. Henry Savage Landor, three lectures on "Tibet and the Tibetans;" Dr. Allan Macfadyen, four lectures on "Toxins and Antitoxins;" Mr. William Poel, three lectures on "English Playhouses in the 15th, 16th, and 17th Centuries;" Sir Alexander Mackenzie, three lectures on "Liszt, Tschaikowsky, Brahms, with musical illustrations;" the Right Hon. Lord Rayleigh, seven lectures on "The Mechanical Properties of Bodies." The Friday evening meetings will begin on January 20th, when a discourse will be delivered by Professor Dewar on "Liquid Hydrogen." Succeeding discourses will probably be given by the Right Hon. Sir Mountstuart E. Grant Duff, Mr. Victor Horsley, Professor H. S. Hele-Shaw, Mr. Richard R. Holmes, Sir Frederick Pollock, Bart., Professor H. L. Callender, the Right Hon. Lord Rayleigh, and other gentlemen. The year 1899 is the Centenary Year of the Royal Institution, and arrangements are being made with a view to its celebration in a fitting manner. Details will be announced at a later period.

A NEW RUSSIAN CRUISER.

MODESTLY, but with a hopeful beginning, the private shipyards of the United States have been called upon recently to undertake the building of war craft for other nations, and Messrs. Cramp, of Philadelphia, have now begun work on a cruiser and a battleship for the Russian Government. The cruiser is an enlargement upon the Japanese Kasagi, which has just left the builders' hands, and which is now in this country having her battery installed. Essentially like her Japanese prototype, the Russian craft is modelled on the lines of the world-known Armstrong cruiser, and modified to a certain extent to harmonise with certain American constructive features and fittings.

The general dimensions and principal features are:—Length between perpendiculars, 400ft.; beam extreme, 32ft.; draught, mean, 19ft. 6in.; displacement, about 6500 tons; indicated horse-power, estimated, 20,000; speed, knots per hour, contract, 23. The batteries will be composed of twelve 6in. rapid-firers, twelve 3in. rapid-firers, and six 47 mm. guns. There will be five torpedo tubes—two above water, one at the bow, and one at the stern, and two submerged, one on either broadside.

Eight of the 6in. guns will be mounted in broadside on the main deck, the two forward and the two after guns on either side being placed in sponsons, permitting a dead-ahead and a straight-astern fire, respectively. All will have very considerable arcs of fire. The four remaining 6in. guns will be mounted two each on the forecastle and on the main deck abaft the after bridge. These guns will have all of the reach of fire their commanding positions make possible, and, like the eight guns amidships, will be well protected by heavy shields. As can be seen from the deck plan, this disposition of the 6in. guns affords a bow and a stern fire of four pieces, and a broadside fire of six. The twelve 3in. guns are mounted on the main and the berth decks. Eight of them are placed amidships between the broadside battery of 6in. guns. Two others are put well forward in sponsons, just under the forecastle; while the last two are mounted in sponsons, one on either side, well aft on the berth deck. All of the guns have wide arcs of fire, and those at the bow and stern can fire ahead and astern respectively, parallel with the centre line. The small guns will be placed on the bridges and up in the tops.



DECK PLAN OF RUSSIAN CRUISER

A protective deck will be worked from stem to stern, being 1½in. thick on the flat and 3in. thick on the slopes. The coal supply, which is said to be large, will be stowed so as to augment the protection about the engines and the boilers. The ship will be driven by two sets of triple-expansion engines actuating twin screws. The engines will be in separate water-tight compartments, and the contract demands that they be equal to sustaining a sea-speed of 23 knots throughout a period of twelve consecutive trial hours. Steam will be supplied by Niclausse water-tube boilers.

The ship will be lighted by electricity, and the same energy will also be used for many of the auxiliaries. Wood will be used but sparingly, and everything will be done to reduce the risk of splinters and the danger of fire in action. As far as possible, the lessons of the war with Spain will be applied to the betterment of this vessel, and when finished in 1900, as she should be, the ship will be essentially up to date in every particular. An engraving of her as she will appear under steam will be found on page 594.

DOCKYARD NOTES.

MONDAY night witnessed one of the now common torpedo boat attacks on Portsmouth harbour. A great deal of powder was burnt, firing was very nearly incessant from 6 o'clock till 10. From the beach between Clarence Pier and Southsea Castle a very good view of the operations was obtainable. The manœuvring of one boat that came in about 7 p.m. was particularly noticeable and good, though quite unsuccessful. This boat appears to have slipped through what may be termed the outer line of search-light defence, but the inner rays soon picked her up, and her turns and evolutions as she attempted to escape this ray were singularly good. The list on this boat as she turned sixteen points with the helm hard a-starboard, and apparently directly afterwards hard a-port, was tremendous, and at one time it looked as though she must capsize. So far as could be made out under the search-light, she was one of the single-screw "80 class" Yarrow boats, which are about nine years old. The failure of this boat to elude the lights goes a long way to prove that no single boat could possibly get into the harbour. At the same time we do not note that the arrangement of lights gives any protection to Spithead anchorage. We further observed on Monday night that practically the whole of the channel between the first fort and Clarence Pier is flooded by the rays.

"LE YACHT" for last Saturday has an optimistic article on coal endurances. Briefly, it makes out that though the nominal radii of action of French ships are low, yet the coal-consumption trials indicate that actual performances are better than the nominal. We rather incline to think that the amateur must be afloat here. A coal consumption trial is at best not a very satisfactory index, for things are done to reach a minimum that could not well be done at sea. Further, those tremendous coal eaters, auxiliary engines, are more often than not excluded. In a modern warship the auxiliary engines consume anything from a-half to pretty well three-quarters as much as the main engines, when the latter are working at low speed. Speaking broadly, to deduct 30 to 50 per cent. from the nominal endurance lands us somewhere near the actual consumption. This is likely to be over the mark rather than under. Where we most fancy we see the amateur, however, is in a glib reference to loading the bunkers to full capacity and then going at full speed. There is not a ship in the French navy able to do this. The article, however, stands a fair sample of the extraordinary optimism that has lately come over our neighbours. We know that sort of thing in America, but our cousins across the herring pond are usually wise enough to leave it as a dogma. The French in everything pertaining to their ships have lately taken to running together statistics to prove that two and two make five.

THE Majestic and Inflexible are at the present time side by side in the new dry docks at Portsmouth. Looking at the two, one cannot help strange reflections on to-day and twenty years ago, when the Inflexible was a huge unwieldy monster. Beside the Majestic she looks a very small craft—about half the size of the newer vessel, though, of course, she is really larger than that. But her minor dimensions are very much emphasised by comparison.

IN the next dock, again, the Formidable is lying, but work on her does not look to be feverish. Hard by in basin lies the Canopus, likely to make a record for delay. Beyond that her masts are now up, she looks very little ahead of what she was six months ago; and six months hence, at present rate, she will still be far from completion.

WITH regard to the question referred to in these columns last week, a Japanese officer who should be in a position to speak more authoritatively on the matter than many people, gives us as his opinion that quite 95 per cent. of shell bursting outside armour within a few feet of a gun muzzle will do so without doing any harm to the gun.

PRIZE-FIRING is not necessarily an exact criterion as to what will happen in war time; but as Captain Orde-Browne has pointed out, there is no valid reason why war vessels should differ much. The prize-firing results of the Imperieuse flag on the Pacific station are as follows:—9·2in. guns, 61 per cent.; 6in., 70·8 per cent.; Hotchkiss quick-firing, 65 per cent. On the face of it this looks exceedingly efficient.

THE Proserpine, in an eight-hours' sea trial at various speeds, natural draught, has just done a maximum of 19 knots with a little over 5000-horse power. She has Thornycroft boilers, made at Keyham. The nominal natural-draught speed is 18·5 knots. The P. class cruisers seem likely to prove very efficient ships; they are built for speed rather than fighting, and they seem likely to be able to fulfil what they were designed for.

So far as can be gathered from the muddle of contradictory semi-official statements and private surmises, it appears that the French do at present intend to have a 14,500-ton battleship. She has as yet, however, only a projected existence, and will not be laid down till well into 1899.

SPEAKING of ships laid down, calls attention to the fact that the London is not yet "laid down," but a good 200 tons weight of material for her is in readiness.

THE Diadem has earned her laurels. As an experiment she steamed from Gibraltar to the Nore in three days, thus having done a continuous sea speed of 20 knots an hour.

ELECTRIC LIGHTING AT ECCLES.

THE new electric lighting works of the Corporation of Eccles were opened this week. The question of electric lighting at this place has for a very long time been under consideration. As long ago as 1894 the late Dr. John Hopkinson was applied to and reported in favour of electric lighting, and Mr. Clirehugh, the Manchester member of the firm of Lacey, Clirehugh, and Sillar, prepared a scheme, which was thrown out owing to a change of Council, a portion of which opposed the borrowing of the loan at the Local Government Board inquiry. Eventually, however, Mr. Clirehugh was asked to slightly modify his scheme, which was approved, and the Local Government Board sanctioned the necessary loan. The present works are the outcome of this scheme, and the plant consists of the following:—Two Lancashire boilers, made by Messrs. Tinkers, of Hyde, 28ft. long by 7ft. 6in. in diameter, supply steam to two engines made by Messrs. Browett, Lindley, and Co., coupled direct to two 120-kilowatt alternators by Messrs. Johnson and Phillips.

As the day load will probably be very small, Eccles being principally a residential district, it has been decided to provide current during the day from accumulators, charged during the time the machinery is at work. A 30-kilowatt alternating-current motor generator by Messrs. Johnson and Phillips is used for charging the cells, which have been provided by Messrs. Pritchetts and Gold.

The ordinary, or "night" load, will be carried on by alternating current generated at 2000 volts. The transformers, as also the switchboards, have been made by Messrs. Cowans.

The site of the station has been well chosen. It is situated on the side of the Bridgwater Canal, from which water is obtained for condensing purposes, Ledward's ejector condensers being used. The mains are Glover's diatrine, lead covered and armoured, and there is some small amount of incandescent street lighting. A feature about the station is the largeness of its units for such a small sized installation. It is a sign that the designer is well aware of what may be expected in the near future—namely, extension. The total cost of the station, plant, mains, &c., is only £20,000, but from this the engineers are confident of getting a substantial return.

ON Saturday last the pier at Southend was wrecked by a small yacht, of about 80 tons, which had dragged her anchor, and was driven by the wind with considerable force into the structure. The cast iron piles snapped like carrots, the decking was dislodged and fell, the tramway line was destroyed, and the length of ironwork forming the western boundary was severed from its connection. The vessel cradled itself between the broken ends of the iron piles, and sank as the tide ebbed. The pier for about 90ft. was completely wrecked and severed in two.

RAILWAY MATTERS.

A SERVICE of trains has just been opened upon the branch line of the Mourgab on the Trans-Caspian line between Merv and Kouschka.

IT is announced in Winnipeg that the Dauphin Railway now being built near the Saskatchewan River will be pushed forward to Hudson Bay within four years, thus opening a new short route to Europe.

THE newly-constructed railway line running between Popassnaya and Nikitovka, in South-Eastern Russia, will shortly be brought into direct passenger and goods communication with the other railways of Russia.

IT is understood that the Newport and Pontypridd Railway is to be taken over by the Great Western Railway. An influential movement is on foot in the Swansea district to get the town placed on the main line.

IT is stated that arrangements are being made whereby the Baker-street and Waterloo Railway, now being constructed between Waterloo Station and the Great Central terminus, will be extended to Paddington and Euston.

A COMMISSION in Sweden has reported in favour of a new and radically changed passenger tariff, a zone system, but unlike other zone systems, with a reduction of nearly one-half from present rates for short distances, and the abolition of nearly all special rates, except for monthly commutation tickets.

DURING October there were 217 accidents on the railways in the United States, of which 111 were collisions, and 105 derailments. Eight were due to defects of the road, thirty-six defects of equipment, sixty-nine to negligence in operating, six to unforeseen obstructions, and ninety-eight are "unexplained."

AN edict has been issued to the effect that all Russian railway carriages must be lighted by electricity by means of a separate accumulator for every carriage. First-class compartments will be lighted by 100-candle power lamps; second-class by 80-candle power, and third class by 50-candle power lights. In every compartment stearine candles must be also supplied in case the electric light refuses to act.

SOME idea of the enormous growth of the bicycle traffic on the railways can be formed from the fact that, in the three months ending September, the Great Northern company had to carry no less than 19,864 machines—viz.: 7435 in July, 7766 in August, and 4663 in September. During Whitsun week the London and South-Western company despached from Waterloo Station alone 4000 cycles, special vans, each with a qualified attendant, being attached to most of the trains.

A DARING and deliberate train-wrecking attempt was made on the Belfast and Northern Counties Railway on Monday night, between Antrim and Belfast. The seven o'clock passenger train, while passing Muckamore signal-box, ran into a number of iron chairs which had been fixed on the rails. The driver immediately stopped the train, and upon investigation found the wheel guard of the engine smashed, as well as a number of chairs, which were scattered in all directions.

A DEPUTATION of the Manchester Corporation paid a visit recently to Glasgow for the purpose of inspecting the New Springburn Mitchell-street electric tramway. The deputation report that (1) the overhead trolley system is the only possible one for Manchester; (2) no nuisance or danger from it is experienced in Glasgow; (3) electric traction has proved so successful there that gradually it will supersede horse traction; and (4) halfpenny fares for short distances are possible and profitable.

THROUGH communication between Moscow and Irkutsk by means of the Trans-Siberian Railway will be opened next May. Till then the trains will travel as far as Krassnoyarsk, where passengers will be conveyed across the Yenissei, as the bridge there is not yet quite ready for traffic. From Yenissei special trains are already travelling to Irkutsk. When the bridge across the Yenissei is finished, the journey from Moscow to Irkutsk, a distance of 3429 miles, will take eight or nine days. The Central Siberian Railway has already been put into direct communication with the international railway system of Europe.

AN extensive scheme has been inaugurated for opening out North Holderness, in Yorkshire. An order has already been obtained for constructing a light railway from Beverley, through Leven, to Beeford. An order has also been granted providing for a line from the latter village to Bridlington. A junction will, in all probability, be formed between the two sections, but at present negotiations are conducted entirely apart, and by different promoters. The first section is known as the North Holderness Light Railway, and a company is being formed of persons who have large interests in the district. The North-Eastern Railway Company are promoting a bill in the next session of Parliament which will give very wide powers with reference to the North Holderness Light Railway, including the total purchase of the concern. The line is to join the North-Eastern Railway system at Beverley.

A SYSTEM of portable or field electric railway has been brought out in Germany with complete success. As described by a correspondent of the *Boston Transcript*, the track consists of easily-transported rail frames made of two rails of the usual field railway profile and connected together by, say, five crossbars; the middle crossbar extends a few inches beyond the rails on either side, and to its ends is bolted an iron yoke or frame in shape of an inverted U, the top of which is high enough to be well clear of the cars. The overhead conductor is supported at the centre of the upper horizontal part of the yoke. The yokes are placed closer together at curves, and at the sharpest curves it may be necessary to fit every rail frame with a yoke in order to keep the overhead conductor sufficiently near the centre of the track. The generating station is fitted in the usual way with a dynamo, and two feeders are led from one station to one end of the track, one being connected to the end of the overhead conductor and the other to the rails. For running the trolley wire, a special truck has been devised. On it are a pair of ladders leaning towards each other, and between them on the floor of the truck is a reel containing wire, and at the top, where their upper ends meet, is supported a guide pulley. By means of this truck a long field line, it is found, can be run out in a surprisingly short space of time.

THE degree to which railway extension is now claiming the attention of the various Governments of South Africa is one of the most cheerful signs of the times. Taught by past experience as to the dangers of injudicious railway building, the Cape Colony in particular is exercising a wise restraint over the disposition to build in every and any quarter where demands for railway facilities are made, or takers-up of concessions are forthcoming. By the Bill which has recently been printed, and which will come before the present Parliament for ratification, the expenditure of a sum of £1,966,350 is authorised on the construction or completion of five several railway sections, of a total length of 505¼ miles, says the *British and South African Export Gazette*. These are the extension from Somerset East *viâ* Cookhouse to King Williamstown, a length of 147 miles; Port Elizabeth *viâ* Humansdorp to Avontuur, 178 miles; Sir Lowry's Pass to Caledon, 53 miles; Kalabaskraal to Pickeniers Kloof, 96¼ miles; and an extension starting from a point near Queenstown to Tarkastad, 30¼ miles. Several of these extensions are portions of older schemes partly realised, and others are works for the first time undertaken, although their surveys were made some time since. All these lines will be of the normal gauge of the Colony—3ft. 6in.—except in the case of the Port Elizabeth to Avontuur section, which will be a light line of 2ft. 6in. gauge only.

NOTES AND MEMORANDA.

FROM the three principal ports in New South Wales, viz., Sydney, Newcastle, and Morpeth, the shipments of wool show an increase of 15,000 bales.

EXPERIMENTS were made a few days ago at Pola, and are shortly to be repeated, with an improvement of Marconi's system of wireless telegraphy, says the Vienna correspondent of the *Times*. It is already possible to determine the presence and course of a vessel distant from six to eight English miles. The improvement is the invention of a young student at the Buda-Pesth Polytechnic, named Bela Schefer.

TELEGRAPHIC messages without the aid of wires have been successfully transmitted from the Eiffel Tower to the Pantheon, in Paris, a distance of 2½ miles. The results obtained are said to have been perfectly clear, even in a thick fog. The transmitter was stationed on the third platform of the Eiffel Tower. In endeavouring to transmit from the Pantheon to the Eiffel Tower no result was obtained, owing to the masses of metal in the latter.

THE first-class protected cruiser Terrible has made a record passage to Malta, and this in spite of very rough weather in the Bay of Biscay. Leaving Portsmouth about 11 a.m. on Sunday, November 27th, she steamed for Malta direct, and made the passage as far as Gibraltar without a single mishap, at an average speed of 18 knots per hour, developing 12,500-horse power. Thence she proceeded to Malta at a speed of 20 to 22 knots, arriving on December 2nd.

THE town of Longton, in Staffordshire, has no public electricity supply, but it can boast at least of one private electric lighting plant, viz., at the gasworks, says the *Electrician*. Current is generated for lighting the purifier house, the governor house, engine-room, manager's room, and offices. The plant consists of a 110-volt continuous-current dynamo, and is capable of supplying sixty 16-candle power incandescent lamps. It has already proved itself eminently useful in enabling the purifiers to be attended to at night on the occasion of a breakdown.

DURING November English shipbuilders put into the water 25 steamers and one battleship, aggregating about 72,604 tons, against 30 vessels, of about 83,603 tons, in October, and 14 vessels, of 34,681 tons, in November last year. For the eleven months English builders have launched 311 vessels, of about 780,315 tons, against about 530,030 tons in the corresponding period of last year. One steamer, of 12,300 tons, was launched at Belfast. The launches in the United Kingdom for the year so far have been 653 vessels, of about 1,293,563 tons gross, against 601 vessels, of about 911,569 tons gross, for the first eleven months of 1897, and is a record.

A MONSTER blast took place in the quarries of the Welsh Granite Company, Trevor, Carnarvonshire, on Wednesday, the 7th inst. The reason for the blast was that the rock was getting very tight and extremely difficult to get at. The quarry is situated at 600ft. above sea level, and the bank to be operated on was 100ft. high. The plans of operations consisted in driving in a heading about 15ft. above the level of the bank. This heading was 53ft. long. Another heading, 23ft. long, was driven to the left of this, and a chamber formed there. A further tunnel was driven to the right, but nearer to the mouth of the first heading. This one was 29ft. long, and a chamber formed at the end. There was very little report, and by measurement it was found that about 80,000 tons of rock were displaced, and fell on the bank exactly as prepared to receive it. A further quantity of 20,000 tons has been loosened. There were 6½ tons of powder used as an exploding charge, and a small Siemens dynamo of 400 volts was used as the exploder. The operations were carried out under the superintendence of Mr. George Farren, M. Inst. C.E.

THE ordinary shop egg is generally looked upon with suspicion, although it is almost invariably labelled "fresh" by enterprising but not over-scrupulous dealers in such commodities. It appears, however, that this title is applied to eggs of almost any age. In an article on the subject which recently appeared in a contemporary devoted to cold storage it is stated that a temperature of 40 deg. is very good for keeping eggs for three months, but if they are held longer than this period they become musty, and it is advocated that a temperature as low as 30 deg. must be maintained for "long period holding." When eggs are put in cold storage they should not be cooled rapidly, says our contemporary. The effect on the egg tissues is bad—they should have time to re-arrange themselves to the changed temperature. This is especially true when eggs are placed in storage in extremely warm weather. Sudden warming is also detrimental to the welfare of an egg, for a similar reason to the above. It appears, however, that eggs stored in cold temperatures for a long period can be detected by the thinness of the white or albumen.

AT a meeting of the Société des Ingénieurs Civils de France, M. E. Maglin made a communication on the casting of bronze statues. In recent times, he observed, several inventors had endeavoured to make moulds of gelatine, the results of which were not encouraging; but it was given to a French sculptor—M. Le Bourg—to devise a method perfect as regards the results obtained, and also the saving in labour. The process in question depends upon the fact that gelatine, with the addition of glycerine and glucose, preserves a constant elasticity even when exposed to the atmosphere; and by its means a statue may be moulded in its entirety, being surrounded by an envelope, or covering, in two parts, which are detached with great facility, while producing moulds of remarkable sharpness. In this manner a wax (*une cire*) is obtained by a single pouring, the seam of the mould joint being easily removed, since it is upon soft wax that the re-touching has to be effected. This done—by the ordinary methods of the waste-wax process—the statue to be reproduced is covered with slip (*barbotine*); the wax is melted out, and the bronze is run into the mould after the gits and vents have been arranged. The specially original point about this method is that, while affording a considerable number of copies, absolutely identical, it is independent alike of the sculptor, the chaser, and the bronze mounter.

PRACTICALLY the whole of the world's supply of platinum comes from Russia. Nearly all the important mines have passed into the hands of foreigners. According to a St. Petersburg newspaper, there is a group of mines concentrated in the Verkhotursk district of the government of Perm, numbering about seventy, of which forty are being worked. In the course of last year several of these passed into the hands of foreigners, including a Paris syndicate having a capital of several million francs, and five out of the existing seven great platinum enterprises in the Urals are now reported to have been purchased by foreigners. There is said to be really no demand in Russia for the metal, and when Russians owned the mines they exported the ore in the rough state to be treated in Germany and other countries. The production of the mines in the Verkhotursk district amounted last year to about six tons. This may not seem a large quantity when we consider that platinum is the heaviest of the metals, excepting the still rarer metal, irridium; but it must be borne in mind that it can only be compared with gold in value. The price per ton was estimated, in connection with the purchase of some of these mines, by the Paris syndicate already referred to, at from £160,000 to £192,000. When it is considered that no new veins of the metal have been discovered in Russia for a long time, and that the present veins will soon be exhausted, it becomes evident that the Russians have lost an important industry, and the only one which enjoyed a monopoly of the world's supply.

MISCELLANEA.

TENDERS have been let to C. G. Hudson for the supply of twenty motor cars for the electric service in Sydney for £5450, and to Ritchie Bros. for twelve combined tramcars at a cost of £3477.

QUEENSLAND is inaugurating a new departure in the fruit trade. An enterprising colonial firm has sent to the Agent-General's Office, in Victoria-street, Westminster, a consignment of dried bananas with the object of opening up a market for them in England.

FOR the South Pier of the Princes Dock, Glasgow, the Clyde Trust have just ordered eight hydraulic travelling cranes of two ton capacity. Four of these will be supplied by the Glenfield Company, Limited, Kilmarnock, and four by Messrs. Fullarton, Hodgart, and Barclay, Limited, Paisley.

THE Birmingham City Council have granted a temporary licence for three months to the Llandudno Motor Touring Company to run three motor omnibuses along a specified route in Birmingham. One is to be started next week and the other two within a month. The Council stipulate that in the centre of the city only the second rate of speed—six miles per hour—is to be used.

THE only absolute preventative against the ravages of the moth in furs is a low temperature, much lower than can be obtained in ordinary dwelling-houses. A company—the Pall Mall Deposit Company, St. Alban's-place—in London has, therefore, had a cold store fitted up by Messrs. Sterne and Co., so that persons possessing valuable furs, skins, tapestries, rugs, &c., may deposit them with safety, not only from burglars, but from the destructive moth.

THE Great Northern Railway has recently obtained a remarkably successful result in some artesian boring operations they have had carried out at Werrington, near Peterborough Station, by Messrs. Le Grand and Sutcliff. At a depth of 132ft. a splendid overflowing spring has been struck which rises to the height of 20ft. above the surface, and the flow is at the rate of 300,000 gallons per diem, which would suffice to supply a town of over 10,000 inhabitants.

BY way of recognising to some extent the eminent services rendered by the chairman, Mr. Edric Bayley, to the Borough Polytechnic Institute, and as a mark of appreciation for his liberal contribution of £2000 to the building fund, the governing body has decided to call the new range of buildings comprising the school of cookery, the physics laboratory and physics lecture theatre by his name, and these schools will accordingly be named "The Edric Bayley Schools."

ACCORDING to the Board of Trade report on the state of the skilled labour market during November based on 2320 returns—viz., 1649 from employers, 535 from trade unions, and 136 from other sources—the general state of employment has been good during November. During the month there has been some improvement, especially in the shipbuilding and tin-plate trades. In the 118 trade unions making returns, with an aggregate membership of 469,844, 10,864—or 2·3 per cent.—were reported as unemployed at the end of November, compared with 2·5 per cent. in October, and with 4·8 per cent. in the 113 unions, with a membership of 464,382, from which returns were received for November, 1897.

AS a result of some previous representative meetings on the subject, a meeting of the leading india-rubber manufacturers of the kingdom was held recently in Manchester to discuss proposals for a combination of the whole trade. The main object of the new association of British rubber manufacturers is to control prices and output in view of competition. After considerable discussion it was determined to form the association, rules were adopted and officers were elected. The feeling prevailed that although prices may be to some extent advanced in consequence of this decision, the rapidly growing competition in all departments of the rubber industry by France, Germany, and America, must continue to be a powerful check upon any such advance.

AN exhaustive article on "Copper Production," reviewing the position from 1879 to date, recently appeared in the *Statist*. The figures given show that the world's production of copper in 1879 was 152,000 tons, against 396,000 in 1897, the largest output on record. The average price for the year 1879 was £57 11s., against £48 18s. 9d. in 1897, the highest price since 1891. In 1888 the price was £76 per ton. The United States contributed 212,000 tons to the 1897 total, Spain 54,000, other countries 130,000—the States output thus being far in excess of all other parts of the world. The diagram accompanying the review shows that the production in the States has been continuously increasing from 1879 to 1897, with exceptions only in 1886 and 1893. Having regard to the extent of the world's consumption of this metal, the available stocks and supplies are smaller than ever previously in the history of the trade, at the present time amounting to only 26,879 tons, or approximately less than six weeks' consumption.

THE first-class battleship Irresistible, of which the first keelplate was laid as recently as April 11th in the present year, was launched at Chatham yesterday by the Princess Christian. The new vessel is of the Formidable class. Her displacement is 15,000 tons. Her engines, made by Messrs. Maudslay, Sons, and Field, will have indicated horse-power of 15,000; her boilers are of the Belleville type, and her speed will be 18 knots. The armament will consist of four 12in. breech-loading wire guns, twelve 6in. quick-fire guns, sixteen 12-pounder quick-fire guns weighing 12 cwt. each, two 12-pounder quick-fire guns weighing 8 cwt. each for boat use, six 3-pounder quick-fire guns, and eight ·45in. Maxims. Four submerged torpedo tubes, and fourteen 18in. and five 14in. torpedoes complete her powers of offence. The thickness of the armour plating in various parts is thus described:—For 216ft. of the sides, 9in.; on bulkheads, 12in., 10in., and 9in.; on barbettes, 12in., 10in., and 6in.; on casemates, 6in.; on fore conning tower, 14in., with 8in. communication tubes; on after conning tower, 3in., with 3in. communication tubes; on the twelve gun-shields, 8in. and 10in.; on the roof and floor of the same, 3in. of Harveyed nickel steel; and as protective plating on bows, 2in. She has also a protective deck.

IN the course of his evidence before the Royal Commission on the London Water Supply on Monday, Mr. Walter Hunter, joint engineer with Mr. Reginald Middleton to the Staines Reservoirs Committee, stated that in his opinion the Staines scheme, whilst providing excellent water, would for at least fifty years, and probably for a much longer period, be more economical, and consequently more advantageous than the Welsh scheme could possibly be. In carrying out the Staines storage reservoirs it was considered desirable, as far as possible, to disarm opposition by falling in with the views of the advisers of the public bodies concerned, especially in connection with the proposals that pumping from the Thames should not commence until fifteen days after the commencement of any flood, and that the minimum flow at Teddington Weir should be fixed at 200,000,000 gallons. For the protection of the river, and for the equalisation of the flow, it was desirable that as much water as possible should be taken from it during the periods of flood. A comparison of the chemical and bacteriological quality of London water with that supplied from mountain districts testified to the excellence of the metropolitan supply. The Thames possessed an average flow of about 1,300,000,000 gallons daily, and it had never been suggested by the supporters of the Welsh scheme that more than 415,000,000 gallons could be obtained from Wales. It therefore seemed absurd to leave a larger and equally good supply obtainable close to London for a smaller supply from a distant source.

NEW RUSSIAN CRUISER

MESSRS. THE WILLIAM CRAMP AND SONS' SHIP AND ENGINE BUILDING COMPANY, PHILADELPHIA, BUILDERS

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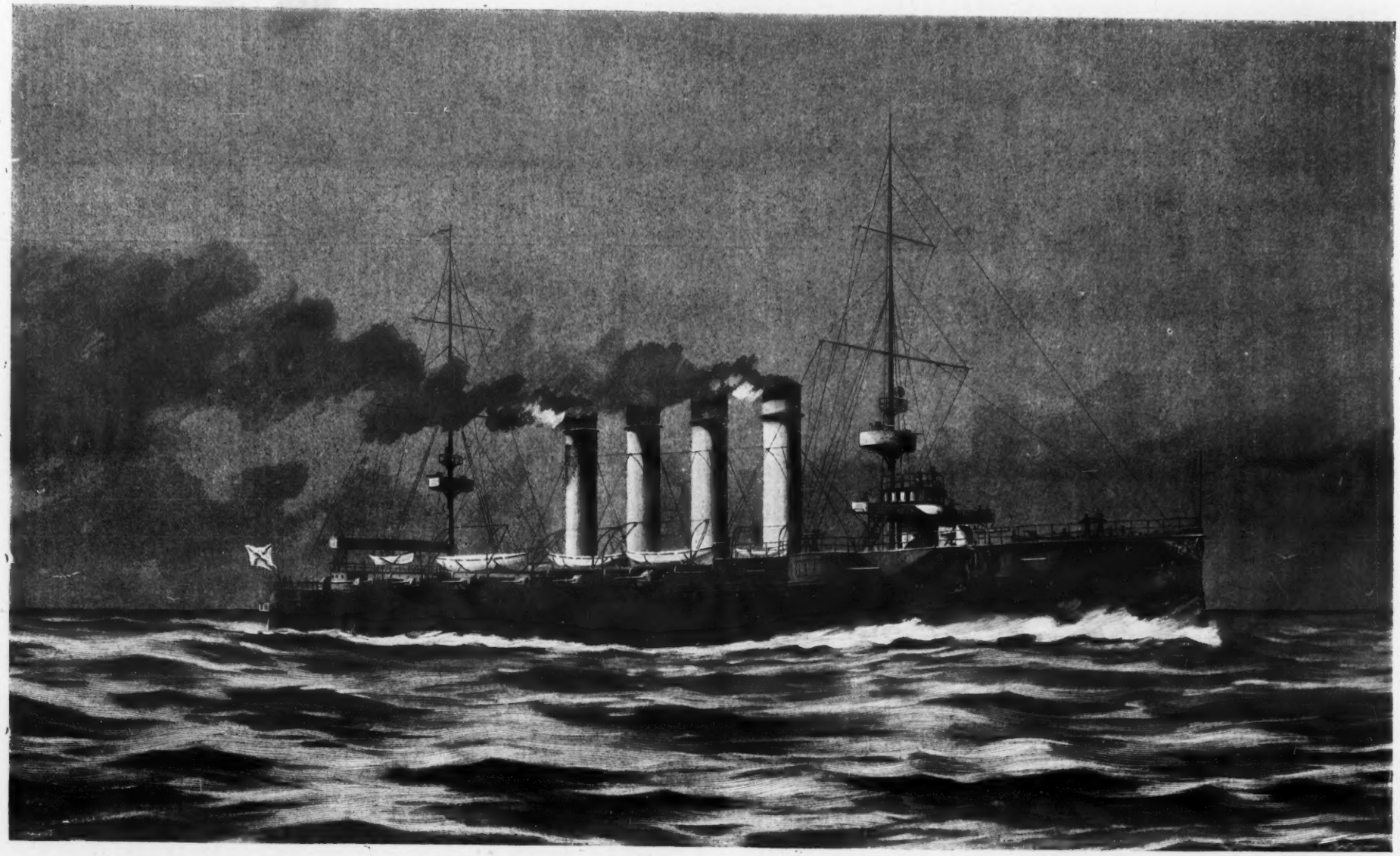

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

J. R. P.—We fancy you will have to make your model rails for yourself. However, you might try Martin, Albion Works, East-road, West Ham.

R. L. (Wanstead).—The makers of oil engines are not very particular as to brand. "Tea Rose" seems to be a good deal in favour; so is Russoline.

A CORRESPONDENT.—Manganate of soda is chiefly used for Condy's green disinfecting fluid. We have made numerous inquiries in Mincing-lane, but can obtain no information as regards the quantity used, &c.

F. J. (Stockport).—There can be no doubt that you will effect a very large saving in coal by doing as you propose. But we are quite unable to say whether the engine you propose to put down is of the proper size, because we know nothing about the power now exerted by the small engines.

AXLE.—Railway axles are made tapering to save weight, and because the axle is strengthened in the same way that tapered stay-bolts, armour-plate bolts, &c., are strengthened. Axles almost invariably break just at the back of the wheel seat. They will certainly break there if there is any sudden change of section.

SMOKE.—We really must ask you to read once again with a little care what we have written. It is beyond question that, given certain conditions, North-country coal can be burned in a Lancashire boiler without making smoke. But it is equally a fact that the requisite conditions cannot be obtained save under special circumstances, which we have fully explained. Those who wish to abolish the smoke nuisance must show how the necessary conditions of steam-making are to be secured.

INQUIRIES.

SPANISH AND PORTUGUESE ENGINEERING BOOKS.

SIR,—Can any reader give me the titles and publishers of good engineering books in Spanish and Portuguese?
December 13th. J. R. P.

MACHINERY FOR PERFORATING CARDBOARD.

SIR,—Can any reader give me the address of any firm who supply machinery for perforating cardboard?
Derby, December 9th. G. S.

SMALL AIR COMPRESSOR CYLINDER.

SIR,—Can any reader inform me where I can purchase a small air compressor cylinder, about 3¼in. stroke? I should be content with castings for same. A. H.

SMALL PUNCHING MACHINES.

SIR,—Can any of your readers give me the address of makers of small punching machines, to punch washers from a soft material, about a quarter of an inch in diameter? E. S.

TRANSVERSE BOGIE SPRINGS.

SIR,—Can any of your large circle of readers give me a formula or information to determine the strength, &c., of the springs for retarding the lateral motion of the bogie for a locomotive engine?
Wakefield, December 10th. *Loco.*

CORRUGATED MOULDING FLASKS.

SIR,—We should feel obliged if any of your readers could tell us names of makers of wrought iron moulding flasks, with corrugated sides and interchangeable set pins. It is very necessary that they should have sides corrugated.
London, December 15th. G. B. H.

ELASTIC BUSHES.

SIR,—We require a material, elastic like india-rubber, to mould into bushes with a spiral steel spring in the walls, and to stand the contact of high-pressure steam—800 lb. per square inch—and the material or alloy to retain its elasticity for a reasonable length of time.
Burley-in-Wharfedale, December 14th. RAPID.

MEETINGS NEXT WEEK.

THE INSTITUTION OF CIVIL ENGINEERS: GLASGOW ASSOCIATION OF STUDENTS.—Monday, December 19th, at 7.45 p.m. Paper, "Evolution and Environment in Engineering," by Mr. David Home Morton, M. Inst. C.E., M.I. Mech. E.

THE INSTITUTION OF CIVIL ENGINEERS.—Tuesday, December 20th, at 8 p.m. Paper to be discussed, "The Ventilation of Tunnels and Buildings," by Mr. Francis Fox, M. Inst. C.E. Paper to be read, "High-speed Engines," by Mr. John Handsley Dales, Assoc. M. Inst. C.E.

ROYAL METEOROLOGICAL SOCIETY. — Wednesday, December 21st, at 7.30 p.m., at the Institution of Civil Engineers, Great George-street, Westminster. Papers, "The West Indian Hurricane, September 1898," by Capt. A. Carpenter, R.N., D.S.O., F.R. Met. Soc.; "The Connection between the Winter Temperature and the Height of the Barometer in North-Western Europe," by Mr. W. H. Dines, B.A., F.R. Met. Soc.

THE INSTITUTION OF ELECTRICAL ENGINEERS.—Thursday, December 22nd, at 8 p.m., at the Institution of Civil Engineers, Great George-street, Westminster. Paper, "Telegraphy by Magnetic Induction," by Mr. S. Evershed, Associate.—The discussion on Dr. Lodge's paper, "Notes on a Process for Treating Slimes without Filtration or Decantation," communicated by Mr. Alfred James, M. Inst. M.M.; "Notes on Fouché's Aëro-Condenser," by Dr. A. L. Simon, M. Inst. M.M.; "The Tin Mines of Bolivia," communicated by Mr. Walter McDermott, President; "On Minerals found in the Silver Lodes of Tatasi and Portugalete, Bolivia," by Mr. Malcolm Roberts, Assoc. Inst. M.M.

DEATH.

On the 12th inst., at his official residence, Woolwich, Sir WILLIAM ANDERSON, K.C.B., in his sixty-fourth year.

THE ENGINEER.

DECEMBER 16, 1898.

THE ENTRANCE EXAMINATIONS OF THE INSTITUTION.

THE establishment of an entrance examination for would-be Associates of the Institution of Civil Engineers has not passed without criticism. The fact, instead of being deplorable, as some of our correspondents seem to think, is one on which the Institution is to be congratulated. It is excellent evidence of a healthy interest in the doings of the Council. If the new departure had been passed over in silence, the profession at large might have gathered that the actions of the Institution were regarded with indifference; while the Council might have taken it for granted that the examinations were perfect in every way, and did not need improvement. The somewhat voluminous correspondence which has appeared in our pages will do away with all possibility of error on both points. Warm interest has been taken in the scheme, and the criticisms which have been passed deserve consideration, and may easily be utilised with benefit in ensuing years.

The adverse comments which have been made, and are still being made, are twofold in character. It is asserted, in the first place, that the right way into the Institution does not lie through an examination hall; and, in the second place, that the papers set are not of the right kind. It is well to consider from whom these objections emanate. They proceed from men who have attained a considerable reputation, and even some eminence in particular branches of the profession, and from young men or middle-aged men who cannot, or at all events think they cannot, pass the examination. A volume might be written on the first point, a similar volume might be written on the second point. We must do the best we can within a very limited space to clear away mistakes. Yet we venture to think it may suffice. It was admitted on all hands that men were crowding into the Institution whose qualifications for membership were based rather on the kindness of their friends than on any special competence manifested by the candidates. As pointed out very neatly by one of our correspondents, the examination affords a means of extending an empty but unavoidable courtesy to our friend. There is, however, the danger that less discretion than ever will be manifested in filling up proposal papers. The examination sieve will be filled too full. Time will show. But be this as it may, it was long since clear that something must be done to render admission to the Institution more exclusive than has recently been the case. It has been by no means an easy task to carry out a novel scheme, and before the recent policy of the Council is censured, it would be well to settle on an alternative scheme which would on the whole work better. It is not to be disputed that the situation has gradually been moulded into one of extreme difficulty. We believe that the Council have acted prudently in adopting the principle of entrance examinations. But we cannot shut our eyes to the fact that grave objections, some of them of a kind that we certainly did not anticipate, have cropped up; and that the movement is not quite the admirable thing that a few superior persons would have us believe. We may say this, and yet hold, as we do, that the Council have done the best that could be done under the circumstances, and for the time being; and we imagine that as time passes and experience is acquired, difficulties will be eliminated and the examinations improved almost beyond criticism.

The objections to the examination papers are quite apart from the objections to the policy of the Institution. Many engineers admit that the policy is right, but the papers are wrong. That the objections are in some respects well founded we do not care to deny. In others, however, they are based on a misconception. It is urged that the examination gives no clue, and can give no clue to the merits or demerits of the candidate as an engineer practising his profession. This is on the whole quite true. But the examination is not in any way intended to settle the point. One of the most curious mistakes made about the whole matter is the understanding that the examination is a pass examination. That is to say, if the examiners are satisfied, then the candidate at once becomes an Associate of the Institute. Nothing can be further from the truth. While he cannot at all become an Associate if he does not pass, the passing in no way secures his election. In a word, the candidate has just the same ordeal to get through as before, and he has the examination thrown in as an extra. The nearest parallel that we can suggest is entrance to a medical school. The would-be student must pass the London matriculation examination, let us say. But passing that does not make him a physician, or a surgeon. The objection to the entrance examination for the Institution is based on the peculiar conditions under which the profession has been practised. In all other cases almost without exception, an entrance examination is passed by young men fresh from school or college. They have at once plenty of time in which to "grind," and that special facility for absorbing book learning which is peculiar to youth. If all the candidates for membership of the Institution were under twenty years of age, we should have heard very few complaints; and we believe that it is the desire of the Council that in process of time this entrance examination shall be passed by very young men—"students" of the Institution, in short. Once through, their names can be subsequently brought forward as candidates for associateship or membership as time passes. But at the present moment there is, no doubt, a large number of men still young, but no longer youthful, who are quite eligible for election as Associates, but who are entirely unable to get through the examinations. It is no disparagement to any one to say that very few engineers in practice could pass without cramming. We do not believe there are five men now on the Council who could get through without preparation. But for this preparation busy men have no time, and the result is that they find themselves excluded from the Institution to which they are very well entitled to belong.

There is more than one way to get over the difficulty; in the first place the Council can, if they see fit, dispense with the examination. Another plan suggested is an alteration in the examination papers, which will enable the candidate to utilise that knowledge which he really possesses, and by which he earns his bread. Unfortunately, it is impossible to do this. The candidate for a diploma in medicine or surgery is tested in the practice of the profession by the examiner. He is shown patients. He has to say what is the matter with them, and how he would treat them. The Institution of Civil Engineers cannot take a candidate to a broken bridge and ask him

why it has broken. They cannot set him down in the fields with a level or a theodolite, and tell him to trace a line of railway; nor can they give him charge of a machine shop, and see how he manages men, or deals with piece-work prices. The practical examination is, to a certain extent, out of the question, although a good deal might be done after the fashion of Board of Trade examinations for master's and engineer's certificates. There remains, then, the examination in theory, and that can, we think, be so conducted that many objectors will be silenced. There are not, we are sure, any engineers in the present day who would attempt to maintain that theory is useless. The examinations of the Institution may very well be directed to ascertaining whether the candidate does or does not understand the inwardness of any given practical problem—the reason why a particular way of doing a given bit of work is better or worse than any other way. It will be a mistake if questions are set which have either no obvious application to engineering practice, or those which, pretending to precision, are not really precise. An instance of this may be found in the question criticised by one of our correspondents on the harmonic period of springs. The question is of no utility whatever to the engineer, save in so far as it represents a certain amount of mental exercise, and it really deals with an extremely abstruse question of vital importance to the chronometer maker, and no one else. The question as set conveys, unfortunately, the impression that the man who drew it does not fully understand the subject himself. We do not know by whom the papers are set, nor is it desirable that the information should be made public; but the papers should in all cases be submitted to the Council, and the members of Council being practical men, ought to have no hesitation in altering and improving them when and where possible.

THE REPORT OF THE LOAD-LINE COMMITTEE.

THE North Atlantic winter freeboard difficulty is removed at last, or, at all events, a sufficiently sure advance has been made towards its complete removal to leave very little doubt that a regulation which for years past has been a source of well-founded irritation to the shippers of New York, Philadelphia, and Boston, will now be so modified as to leave no further ground for complaint. From time to time, during recent years, this subject has been discussed in the columns of THE ENGINEER, and at different stages of the controversy we have afforded our readers glimpses of the situation. It will therefore probably be sufficient if we now briefly indicate the circumstances which led up to the appointment of the Committee which has just presented its report to the Board of Trade on the North Atlantic winter load-line.

When the first Load-line Committee considered the question about nine years ago, it very properly took cognisance of the special conditions attendant upon the navigation of the North Atlantic Ocean in winter. Accordingly the freeboard rules and tables then adopted by Parliament provided not only for a winter freeboard in excess of that required for each vessel in summer, but also required a further excess of freeboard for vessels crossing the North Atlantic in winter, between European ports and all ports on the eastern shores of North America, north of the entrance to Chesapeake Bay. Now, it so happens that owing to the northerly trend of that land-locked piece of water, the port of Baltimore, situated at its upper extremity, is a great deal north of the entrance to the bay. Hence, by the load-line tables, a vessel trading between a European port and Baltimore required a greater freeboard by several inches than would be allowed if she ran between the same port and Newport News at the southern end of the bay. This was evidently unreasonable, as to reach the entrance of the bay the same track would be steered in both cases, and after entering the bay the vessel is practically in still water for the rest of her voyage. The merchants of Baltimore therefore petitioned the Board of Trade of this country to amend the freeboard rules by putting all the other ports in Chesapeake Bay upon the same footing as Newport News. As the Load-line Committee had already decided that the entrance to that bay was sufficiently far south of the winter storm tracks to render unnecessary a specially lighter loading of vessels proceeding thither from Europe, the application of the Baltimore merchants was acceded to. This proved to be the beginning of a greater trouble by far than that which the measure had sought to allay. For Baltimore is so close to Philadelphia, New York, and even Boston, that a very unfair competition was at once established. British vessels leaving Baltimore were allowed to load considerably deeper than those from the ports a little to the north, and hence Baltimore was preferred to her competing neighbours. The great trunk lines of railway in America could as easily convey export produce to Baltimore as to New York, Philadelphia, or Boston, and so it was speedily found that Baltimore was prospering at the cost of her maritime rivals. At once a cry arose from the latter, and petitions were sent from their merchants and shippers to the Board of Trade, requesting that, whether by levelling up or levelling down, the four ports might be put upon the same competitive conditions so far as depth of loading was concerned. At the same time these bodies did not conceal their wish that equality of conditions might, if possible, be restored by removing the North Atlantic winter freeboard restriction altogether.

Such was the state of affairs at the end of last winter, and our transatlantic cousins were then being backed up by shipowners and merchants on this side in their efforts to induce the Board of Trade to inquire into the matter at once with a view to the abrogation of the objectionable regulations before the commencement of another winter navigation season. In discussing the question at the time in THE ENGINEER we supported the claims of Philadelphia, New York, and Boston, so far as their own disabilities were concerned, but we were unable to go so far as to agree with them in their demand that the winter North Atlantic line might be wholly abolished. On the contrary, we pointed out that even the entrance to Chesapeake Bay was within the limits of the North Atlantic winter storm area, and that the proper course would be to extend the additional freeboard requirement so far south as Cape Hatteras. It is, therefore, with satisfaction we find that the report of the last appointed Load-line Committee include this among their other recommendations.

But we are anticipating somewhat. On March 18th of this year the Board of Trade appointed a small Committee to consider certain representations made to them to the effect:—"(1) That the immunity at present enjoyed by the ports in Chesapeake Bay from the Load-line Regulations as to winter North Atlantic freeboard cannot be justified, inasmuch as vessels sailing to and from these ports follow the same course across the North Atlantic as vessels sailing to and from Atlantic ports north of Baltimore. (2) That the result of the said immunity acts prejudicially against the ports north of Baltimore, and in favour of the ports in Chesapeake Bay, and to advise whether, in the interests of life and property, it is expedient that the Load-line Rules should be altered, so as to make the winter North Atlantic freeboard regulations applicable to all vessels following the same course across the Atlantic as is now followed by vessels sailing to and from ports north of 37 deg. 30 min. north latitude."

The object sought in this reference was clearly to meet the complaints of the Shipping Communities on the North American Atlantic seaboard, without raising any other questions in connection with North Atlantic navigation. But when the small Committee to whom this reference was submitted began to consider the question, they found other points arose which, in their opinion, also demanded investigation, and so they requested the Board of Trade to extend the scope of the reference. On May 28th it was extended as follows:—"(1) To consider the operation of the North Atlantic winter freeboard as prescribed by the 'Load-line Tables,' and to report, if any, and, if so, what modification is required in the 'Load-line Tables' in the application of such freeboard, and to advise as to the area through which such freeboard should be in force. (2) To examine the present mode of assigning freeboards to vessels of the 'turret deck' type, and to advise if any modification be necessary. (3) To advise as to the extension of the present 'Load-line Tables' for steam vessels not having spar or awning decks, so as to make them applicable to vessels of moulded depths up to 45ft."

In looking into this extended reference, it will be seen that it deals with matters concerning which the shipping communities in the United States, who first agitated for reconsideration of the freeboard regulations, were for the most part indifferent. All they wanted was equality of treatment between port and port; but what the Committee sought for in the extended reference was to obtain fairness of treatment between ship and ship, having regard to their seagoing qualities and general suitability for transatlantic navigation. This was only reasonable; but on our American cousins hearing of what was being done they began to fear that so large a scope of reference would mean a long-enduring inquiry and a much-delayed report. Hence they wrote a strong appeal to the Board of Trade to hasten the settlement of their own troubles, so that the injustice they complained of might be removed before the winter navigation season set in. The Committee were, however, unable to wholly disassociate the two sets of questions, and so it happens that December has come before they have obtained a pronouncement in favour of putting all the ports on the eastern seaboard of North America, north of Cape Hatteras, upon the same terms of depth of loading.

The enlarged scope of reference necessarily demanded an enlarged Committee, capable of dealing with all the points involved in it. The report of that Committee is not only, in our opinion, wise and judicious, but it has the eminent advantage of being unanimous. It is presented without one dissentient voice from the sixteen gentlemen who composed the Committee. Such a report cannot fail to command confidence on both sides of the Atlantic. It commences by recommending that the same rules as to load lines should be applied to all vessels trading to and from the United States ports north of Cape Hatteras. This, as we have already remarked, was the opinion expressed in THE ENGINEER before the Committee was appointed. But when the Committee proceed to consider what those rules should be, they do not find themselves in a position to recommend that the existing freeboard regulations should continue to be enforced, nor do they consider that the winter North Atlantic additional freeboard should be abolished altogether. After taking into consideration all the evidence taken by them during their inquiry, they came to the conclusion that the additional winter freeboard should be reduced, and that only vessels of the larger type should be wholly exempted therefrom. The tables and appendices attached to their report are too lengthy to be quoted here; it must suffice to say that they recommend a reduction "to a uniform increase of 2in. for steamers up to and inclusive of 330ft. in length," and to dispense with it in all steamers above that length. For sailing ships they recommend a uniform addition of 3in. to the ordinary winter freeboard for North Atlantic winter voyages. The Committee further consider that vessels of the "turret" type are deserving of a somewhat larger allowance than they are at present receiving, but think that the "trunk" type of vessels have already received sufficiently favourable treatment. The report concludes with a recommendation, the wisdom and justice of which will be generally admitted. Up to the present time the percentage of surplus buoyancy required for very large vessels has been undoubtedly too great. The suggested regulations embody a small reduction in the freeboard of vessels a little below 408ft. in length, and a fixed proportion of reserved buoyancy—instead of a rapidly increasing one—for all ships of a greater length than 456ft.

Viewed as a whole, these recommendations are worthy of the eminent men who made them, and should become law at the earliest possible date. If we have any hesitation at all in endorsing them, it is in regard to the condition which fixes the limit at which an additional freeboard is required on the North Atlantic in winter. All limits are necessarily arbitrary, for no one can say that a vessel 331ft. long is any better for ocean navigation in winter than one 329ft. long. But what we do say is that there are many steamers 300ft. long which are much better fitted for North Atlantic work in winter than others of 350ft. Surely length is not the all-in-all when considering this matter. Does not age and antiquity of design and construction come in somewhere when settling such a point? But the whole question is beset with difficulties, and at the best only a reasonable compromise can be arrived at. The Committee are to be congratulated upon the good work they have done in a comparatively short period of time, and it is to be hoped that the results in the working of the regulations about to be issued will be such as to justify their recommendations.

EFFECT OF THE LATE WAR ON THE AMERICAN NAVY.

SHREWD as the Americans have always shown themselves to be in questions connected with war material, like everyone else they benefit by having their armaments tested by operations of war. It is not surprising to read, therefore, that their fleet is now considered to be in much better condition for service than some months ago. How, indeed, could it be otherwise? Everything has been looked up and put in order; supplies of ammunition have been provided; work on ships pressed forward; crews formed, men drilled; in fact, all the efforts that a war calls for have been made, and there are no losses to set off against this except the lamentable loss of the Maine before the war began. The distinct lessons of the war as read by American officers must, nevertheless, have special interest, however obvious some of them may be; and apart from the question of increase in naval power, we now learn the following are prominent among them:—Gunnery competition is greatly stimulated, and this is apparently carried out in the most practical way at sea under service conditions at unknown ranges. In this competition, we are told, the Texas stands the first with an average of 92 per cent., a figure which sounds high, but which has no significance to us, because we do not know the conditions of trial. The fact, however, is apparent that the experience learned in the war has led to increased efforts to cultivate accurate shooting. Simple as it may seem, there is need to insist on the principle that whatever disappointment may occur from failure in war to come up to the standard of practice shooting, the measure of this falling short is to be reduced, like almost every other fault, by dealing with it in a business-like way, that is, by patiently seeking out the causes and grappling with them. Perhaps the most important principles are to imitate service conditions as closely as possible, and, as has been suggested while supplying the simplest possible rules to fall back upon in any difficulty on service, to leave an opening for the exercise of such skill as may attain to any special achievement that may present itself; in fact, to supply a simple course to fall back upon in any case of doubt, with an eye open to a more ambitious alternative when feasible.

Our business, however, is more with war material than gunnery, and we pass quickly on to the next matter, which is the introduction of heavier quick-fire guns. Our readers hardly need to be told that we—and by this we not exclude other writers who have supported us—have not only advocated this for years past, but have dwelt with amaze on the fact that the Americans contented themselves with 4in. or 5in. quick-firing pieces. Nay, we have gone much farther, we have said we were so certain that American officers must see this themselves, that we could not believe that the New York would ever go into action with her powerless little 4in. quick-firing guns. As a matter of fact, she has not tested their powers in this war. It was, however, by the merest accident that she was away when the Spanish cruisers came out of Santiago Harbour to run the gauntlet of the fire of the American ships. The New York, had she not been just out of reach, would doubtless have taken a prominent part in the chase, and under the conditions that obtained we do not see how her weakness would have been brought out, associated as she would have been with other ships. Nevertheless, the fact remains, and we defy anyone to disprove it, that could the New York and the Cristobal Colon have met ship to ship, and been both fairly well fought, the issue could hardly have been doubtful, for the New York would have been fighting with six 8in. ordinary guns and twelve 4in. quick firing pieces. The former pieces could only perforate even the upper structure of her adversary, covered as it is by 6in. Harveyed armour, under the most favourable circumstances, and then with dead metal. On the other hand, the Colon with two 10in. ordinary guns, ten 6in. quick-firing pieces, and six 4·7in. quick-firing pieces, ought to have riddled the upper structure of the New York with common shell, sweeping her men away with langridge and setting her on fire easily. Had this disheartening result happened we should have lamented it only less than the Americans; but the fact remains, and there is no use blinking it, that had these two vessels met alone, no skill or gallantry on the part of the Americans could have averted the result we describe. An armoured cruiser of 8200 tons displacement was bound to fight one of 6840 tons if she met her, and then nothing but the most terrible failure on the part of the Colon could prevent the speedy destruction of the New York. We said this, or what amounted to this, years ago, and we say it again, and challenge contradiction; and we would point out that while we admit that the Americans literally disproved our conjectural statement as to the New York never being allowed to go into action with her existing feeble armament, they will

practically endorse our judgment by taking very good care that she runs no such risk again.

Our article on 8in. and 7·5in. quick-fire guns will show how completely we agree with American officers in their decision to employ 8in. quick-firing pieces in their future armaments. With regard to muzzle velocity, we should with them desire to obtain 3000 foot-seconds, but we are very much mistaken if this is at present a practical achievement. If it is even obtained with a new piece under the most favourable circumstances, it means that the American new smokeless powder in this respect altogether beats our cordite; and this reminds us that one of the most obvious lessons of the war is the need of smokeless powder. The toleration of powder giving smoke was one of few extraordinary lapses of American progress. We say a lapse, for we doubt if the ships of any European navy of high rank would have been caught with such powder on board. That America, who literally sprang to the front with Harvey armour, and showed such grasp in the construction of warships and guns, should have been thus caught napping seems extraordinary. To return, however, to high velocities. It is comparatively easy to get them from a new gun, but to maintain them under the rapid erosion of smokeless powder is quite another thing. It would be rash to say that some powder may not be arrived at which has the most desirable quality of dealing mildly with the bore of the gun, assisted, no doubt, by cunningly devised gas checks. Great things are claimed for the new Russian powder, but we have yet to be convinced that 3000 foot-seconds muzzle velocity is attainable with a piece that has fired, say, fifty rounds, especially with powder possessing the requirements demanded for service as to stability, keeping qualities, and fairly uniform pressure in varying temperatures. The next step brought about is one which, as we have said on another occasion, must be followed by us all except the Germans, who have forestalled us, namely, the removal of wood, which exposes a ship to be set on fire in her upper parts so rapidly, and burning so violently, as to entail destruction on a vessel that may be completely protected as to her primary or vital parts. Deck hamper, boats, &c., must somehow be got out of the way. Indeed, few boats would be found seaworthy on a ship that had been exposed to the sweeping hail of quick fire. It almost goes without saying that increased attention is directed to hose and fire-extinguishing gear. Minor questions are mentioned as further calls for attention, such as paint, and there remain numbers unmentioned which we think must come up, especially connected with engines, stoking, coal or alternative fuel, attention to bottoms, and all that affects a ship's speed. Possibly some questions stand over for the moment, not from want of appreciation, but because elements need investigation before a decision can be arrived at, a decision in which happily at the present moment soundness is more important than celerity.

DISTRICT SURVEYORS.

A DECISION of considerable importance in regard to district surveyors under the London Building Act, 1894, has just been arrived at by a committee of the London County Council. It may be remembered that a few months ago the County Council was approached with a view to an alteration being made respecting district surveyors, so that they should devote the whole of their time to the duties of surveying, that they should be paid a salary by the County Council instead of by fees, and that an office should be provided at the hall of each local authority so as to bring the latter in closer connection with the district surveyor. The movement, although originating with the Vestry of Battersea, has been well supported by the other local authorities, who approached the County Council in advocacy of the proposal. The scheme, which was mainly prompted by the proceedings revealed in connection with the fatality at the Abbey Mansions several months ago, has, however, been nipped in the bud by the Building Act Committee of the County Council. The Committee, in a report which has not yet been placed before the County Council, but which is being addressed to the local authorities throughout the metropolis, state that the proposal that district surveyors should devote the whole of their time to the duties of district surveying could not be carried out, and that parliamentary powers would be required for the purpose. Notwithstanding this, the Committee point out that this practice is being gradually adopted by the Council as fresh appointments are made, and that thirteen district surveyors have already been appointed on this basis. With regard to the suggested remuneration of district surveyors by salary, the Committee are not prepared to advise the alteration of the existing method of payment by fees until further experience has been gained. As to the proposal in favour of the provision of an office at the local vestry hall, the Committee express the opinion that this has much to recommend it, but they do not see their way to suggest to the Council that any steps should be taken in this direction, as, unfortunately, the districts do not coincide with the Local Government areas, and Parliamentary powers might be necessary before such a suggestion could be carried into effect. An explanation of the matter, we may mention, is afforded by the fact that, whereas there are only forty-two vestries and district boards, there are sixty-eight district surveyors, the areas being divided and overlapping one another. It appears, too, that some misapprehension has arisen as regards the duties of district surveyors, and in order to remove this, notices are on the point of being issued for posting up in the offices of these gentlemen intimating that the district surveyors are not concerned with the question of drains and other sanitary arrangements, but that these matters are under the control of the local authorities.

THE ENGINEERING TRADES AND PETROLEUM.

THE position and prospects of the petroleum industry about this time of the year are generally a matter of interest to petroleum engineers, and to the large number of engineering firms who, whilst not focussing their energies entirely on that line of trade, yet make some of the various kinds of machinery and plant which oil production and distribution necessitates—such as boring tools and plant for drilling the wells, tank steamers for conveying purposes, metal barrels for storage, oil engines, and various other manufactures incidental to the oil industry. With regard to the American oil fields, the requirements for the winter trade have been exceptionally urgent this year, and the rush in shipments has been greater than ever. These requirements appear now to have been supplied, and the demand for ships has quieted down. The produce of the oil runs and exportation are about balanced, as recent developments in the American oil fields do not indicate any material increase or decrease in production. The total production of the oil fields of Southern Russia for the first half of 1898 has just been returned as somewhat over 27 million barrels—nine poods to one barrel. About 25 per cent. of this was produced by flowing wells. There are 935 wells producing oil, of which 29 are described as being flowing wells. The British imports of Russian illuminating oil between 1891 and 1897 declined from 7,600,000 poods to 4½ million poods; but during the same period our imports of American illuminating oil rose from 15 million poods to 25 million. In the Dutch East Indies a good many wells are running dry; but there is much new territory—practically half Sumatra—which has not been worked, and which gives every indication of being a good oil region. A good deal of oil from the Dutch East Indies finds its way to Japan, which country imported kerosene oil last year, from various sources, to the extent of 25 million gallons, of the value of £350,000. About two million gallons was used by the Japanese farmers to destroy the blight on the native rice crop. The prospects of British oil-machinery firms are decidedly good, to whichever point of the trade horizon the gaze is directed.

LITERATURE.

The Law and Practice under the Patents and Trade Marks Acts, 1883 to 1888; with the practice in Actions for Infringement of Patent, and an Appendix of Orders made in Patent Actions and Forms. By WILLIAM NORTON LAWSON, M.A. Third edition by the Author, assisted by CHARLES SHARP and MARSHALL DENHAM WARMINGTON, M.A. London: Butterworth and Co. 1898.

THIS is a well written, well arranged, and well indexed work. The latter point is one the importance of which has too often been overlooked by writers on legal subjects, and especially on patent law. The book also contrasts favourably with others of the same class by its size being kept within reasonable limits, extending as it does over somewhat less than 700 octavo pages. The plan of the book, although not novel, is good, the sections of the various Acts being taken in order and serving as the text of an essay, sometimes quite short, and sometimes extending over several pages, dealing with the cases bearing on the interpretation of the section. The cases cited by the author are well chosen, and the decisions are quoted fairly, not being, as is sometimes the case, distorted to support the pet theories of the author. The work does not pretend to be a treatise dealing generally with the history and law of patents, designs, and trade marks, but is limited to the law as it at present stands, and this, as is stated above, it does thoroughly well. We have endeavoured in vain to discover any serious error or omission, and in a book of such general excellence it would be unfair to lay any stress on the few minor blemishes we have been able to detect. We may, however, mention that in this work, the decision of the House of Lords in the Eastman case, which revolutionised the practice in trade marks, is hardly given the prominence which it deserves, and that the protocols varying the International Convention have been overlooked.

Thermodynamics of the Steam Engine. By CECIL H. PEABODY, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology, Fourth edition. New York: John Wiley and Sons. London: Chapman and Hall, 1898.

THIS well-known book has followed up and developed the method of treatment of the subject of thermodynamics inaugurated by Professor Cotterill in his pioneering work on the steam engine considered as a heat engine. It is designed to give instruction to students in technical schools in the methods and results of the application of thermodynamics to engineering. With this object the abstract formulas are always followed by some well-chosen numerical exercises illustrative of the general algebraical theory. The feature in which this book differs from most similar works is in the treatment of the steam engine. It has been deemed advisable to avoid all approximate theories based on the assumption of adiabatic changes of steam in an engine cylinder, and instead to make a systematic study of engine tests, with the view of finding what is actually known on the subject, and how future investigations and improvements may be made. For this purpose a large number of tests have been collected, arranged, and compared; Hirn's researches and experiments being employed as a basis. In another edition the diagrammatic representation of the various destinies of the steam passing through an engine, as drawn up by the Committee of the Institution of Mechanical Engineers, may well find a place. The elusive notion of entropy is introduced on page 22, but the author is obliged to delay the explanation, and to give an *à posteriori* definition subsequently. It is a well known difficulty in the subject, and there is a tradition of a student who asked Lord Kelvin for an explanation, receiving the answer, "It was a very bad name for it."

In the discussion of the properties of gases and vapours the original experimental data on which the working equations must be based are given fully, so as to afford an idea of the accuracy attainable in calculations made with their aid; and Professor Rowland's determination of the mechanical equivalent of heat has been adopted, one caloric = 427·1 Baltimore metre-kilogrammes (not kilogrammes, as on page 96), and with it his determination of the specific heat of water at low temperatures from 0 deg. to 40 deg. Cent. Engineers refuse to adopt the Centigrade scale of temperature, so there is always some risk of error in consulting the tables. Directions are given in the book for testing engines, and for designing simple and compound engines. A mere reference to the table of contents will show the comprehensive scope of the work. Chapters have been added on compressed air and refrigerating machines; here the principles of thermodynamics receive their fullest practical application, and their heat economy is a striking contrast with the glaring but unavoidable waste of the steam engine. The liquefaction of air is assuming commercial importance, and will require description in another edition, among the other refrigerating systems.

The theta-phi, or temperature-entropy diagram, is defined on page 37, but the author has not made such full use of it as is desirable in estimating the performance in a test of a steam engine.

The Theta-phi Diagram. By HENRY A. GOLDING, A.M.I.M.E. The Technical Publishing Company, Manchester. 1898.

THE theta-phi, or temperature-entropy diagram, is a graphic representation of the thermal changes which take place in a steam engine cylinder during one cycle. It is plotted on a theta-phi chart, by calculations of an experiment made with the mean indicator diagram, which is plotted on the pee-vee ($p \cdot v$) or pressure volume chart, by the mechanical action of the indicator. As an aid to the thermo-dynamic study of the steam engine, the theta-phi diagram is more useful than the better known pee-vee indicator diagram, as it shows at a glance the thermal efficiency of the engine. The ordinary indicator diagram shows only the amount of work done, independent of the amount of steam used; but the theta-phi—or $\theta\,\phi$ as the author writes it in the sequel—diagram shows by its area the proportion of heat utilised to the heat received. Diagrams of an engine test in the future must show both diagrams as in Fig. 12, in order to give an adequate representation of the performance and qualities of the engine. The introduction of the $\theta\,\phi$ diagram is due to Mr. Macfarlane Gray, in his paper before the Paris meeting of the Institution of Mechanical Engineers in 1889, and the practical application was taken up by the late Mr. P. W. Willans; since then Captain H. R. Sankey has extended the subject by applying the diagram to the marine engines tested by the Research Committee of the Institution of Mechanical Engineers. Similar diagrams appear in this book as Figs. 16 to 19. Captain Sankey supplies a short introduction, in which he calls attention to the work of Willard—not William—Gibbs in 1873. Maxwell seized on Gibbs' notions and utilised them in the second edition of his "Theory of Heat," but the co-ordinate quantities employed by Maxwell in his "Thermo-dynamic Surface" are the volume, entropy, and energy. Captain Sankey's "Temperature-entropy Chart," published recently, will assist, in conjunction with the present work, in popularising this important practical application of thermodynamics.

BOOKS RECEIVED.

Résistance des Bouches-à-Feu. Par P. Laurent. Paris: Gauthier-Villars, Masson et Cie. Price 2f. 50c. and 3f.

Annuaire pour l'An' 1899. Publie par le Bureau des Longitudes avec des Notices Scientifiques. Paris: Gauthier-Villars. Price 1f. 50c.

Who's Who? 1899: An Annual Biographical Dictionary. Edited by Douglas Sladen. Fifty-first year of issue. London: Adam and Charles Black. 1899. Price 3s. 6d. net.

Journal and Proceedings of the Royal Society of New South Wales for 1897. Vol. xxxi. Edited by the Honorary Secretaries. Sydney: Published by the Society. London Agents: George Robertson and Co. 1897.

The Purification of Sewage: Being an Account of the Scientific Principles of Sewage Purification, and their Practical Application. By Sidney Barwise, M.D. (Lond.). London: Crosby Lockwood and Son. 1899. Price 5s.

Railways: A Fortnightly Journal devoted to the interests of Railways, Tramways, &c., in India. Edited by E. Weatherdon (late East Indian Railway). Vol. i., No. 1, November 16th, 1898. Single copy, As. 8.

The Gold-fields of Australasia. By Karl Schmeisser, assisted by Bergassessor Dr. Karl Vogelsang. Translated by Henry Louis, M.A., &c. &c. With maps, plans, and illustrations. London: Macmillan and Co., Limited. 1898. Price 30s. net.

Marine Boilers: Their Construction and Working; Dealing more especially with Tubulous Boilers. By L. E. Bertin. Translated and edited by Leslie S. Robertson. With a preface by Sir William White, K.C.B. With upwards of 250 illustrations. London: John Murray. 1898. Price 18s.

The Life Story of the late Sir Charles Tilston Bright, Civil Engineer: With which is incorporated the story of the Atlantic Cable, and the First Telegraph to India and the Colonies. By his brother, Edward Brailsford Bright, and his son Charles Bright, F.R.S.E. Vols. i. and ii. Westminster: Archibald Constable and Co., 2, Whitehall-gardens. Price 63s. net the two vols.

ALMANACS, DIARIES, &c.

Waterlow Bros. and Layton, Limited. Architects' and Surveyor' Diary, 1899. London: Waterlow Bros. and Layton, Limited. Price 3s. 6d.

The Gloucester Diary for 1899, issued by the Gloucester Railway Carriage and Wagon Company, Limited, has made its appearance. An ordinary calendar has been added to the exceedingly useful and ingenious Directors' Calendar.

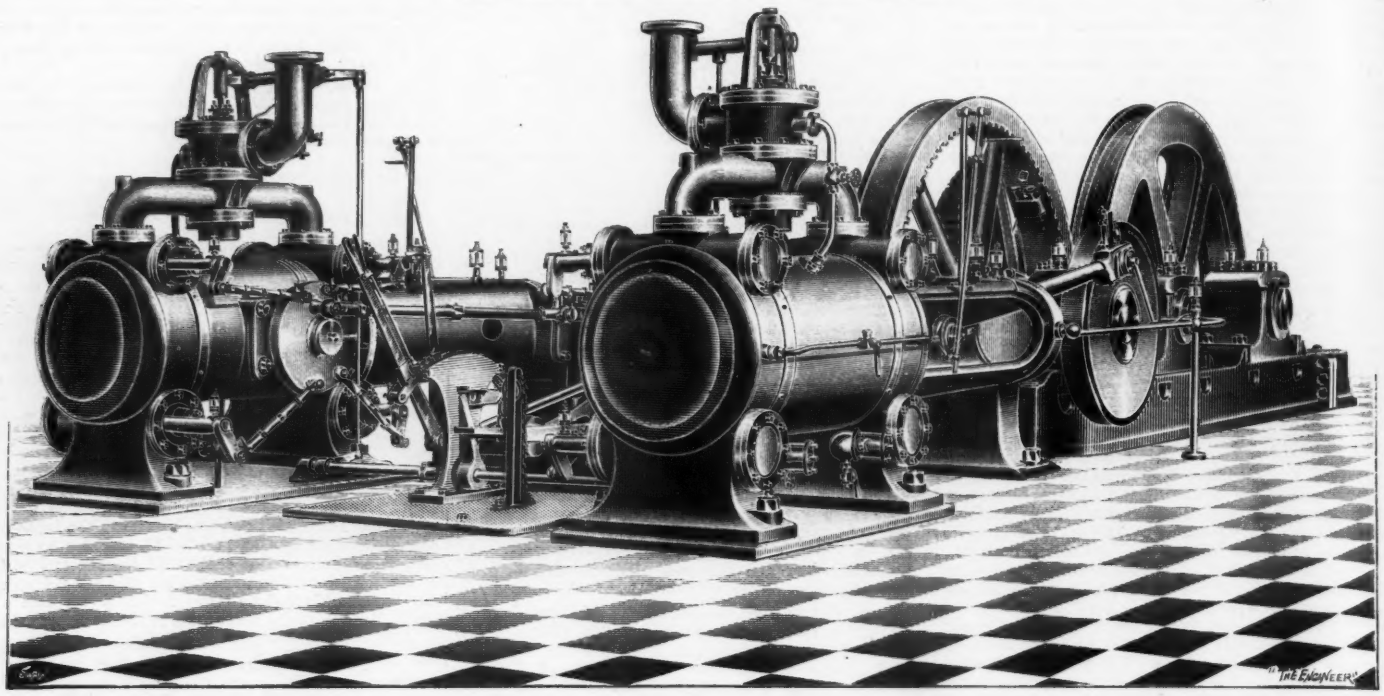
Messrs. McCorquodale and Co., Limited, London, have sent us the Railway Diary and Officials' Directory and the Railway Almanac for the ensuing year.—For railway engineers and officials generally these are excellent productions.

We have received a copy of Calvert's Mechanics' Almanac for 1899.—This inexpensive little work has now reached its twenty-sixth year of publication. Its mission is to improve the knowledge of practical men whose education has been somewhat limited. On this account advanced data, such as algebraical formulæ, have been easily avoided. The work is therefore just what it claims to be—an everyday reference book for the artisan, and at the price of fourpence should find its way into the homes of all mechanics.

THE first-class cruiser Diadem arrived at the Nore on Tuesday afternoon from Gibraltar in advance of the eastern division of the Channel Squadron. The Diadem left Gibraltar on Friday afternoon with the other ships of the squadron, but instead of cruising with them to England she was ordered to carry out a trial run to the Nore. She completed the voyage in three days, at the rate of twenty knots an hour.

HAULING ENGINE, ANSLEY HALL COAL AND IRON COMPANY

MESSRS. ROBEY AND CO., LIMITED, LINCOLN, ENGINEERS



CORLISS GEAR HAULING ENGINE.

THE engine illustrated is, as will be seen, of the coupled horizontal type, with Corliss admission and exhaust valves worked from wrist plates, and is provided with link motion reversing gear of the Stephenson type. The cylinders are 20in. diameter by 40in. stroke, fitted with loose liners, the space round the liners forming steam jackets connected with live steam from the boiler side of stop valve by copper pipes. Automatic drain cocks and relief valves are provided. The pistons are of strong construction, and with large wearing surfaces. Each cylinder is fitted with a "Robey" improved equilibrium stop valve, having steam balance cylinders, and connected by levers to the driver's footplate. The engine frames are of the bayonet girder type, bored out for the crosshead, the main bearings for the disc shaft forming part of the same casting. A massive foot is provided under each bored guide, and the main bearing end is bolted to a strong girder-box bed carrying the hauling gear. Heavy cast iron steps, 8in. diameter, 16in. long, lined with Babbit metal, are fitted for disc shaft bearings, and provided with adjustment for wear. The fly-wheel is of heavy section, and is fitted with barring gear and a powerful foot brake.

The hauling gear consists of two trains of cast iron spur wheels, the first having a ratio of 2 to 1, and the second 4·7 to 1. The main driving pinion on the disc shaft is of steel, cast in halves, and each wheel is shrouded up to pitch line. The second motion shaft is 11in. diameter, with bearings 10in. by 20in., and the drum shaft 12in. diameter, with bearings 11in. by 22in. The hauling drum, which is of the fleeting tread type, is 10ft. diameter by 8½in. wide, in halves, and is fitted with a removable steel tread in segments, secured to the drum by countersunk bolts.

All the brake, starting, and other reversing levers are handily arranged on driver's footplate. The whole of the work and materials throughout is of the highest class, and no trouble has been spared to make the whole plant thoroughly complete. Hand rails, indicator cocks and gear, and special oiling arrangements are provided.

The duty the engine has to do is to haul 85 tons of coal per hour from the bottom of an inclined plane 800 yards long, having a gradient of 1 in 2½, and along a plane in the same straight line 255 yards long, with a gradient in the opposite direction of 1 in 144 in favour of the load. The engine is erected on the surface, at a distance of 120ft. from the pit shaft.

The system of haulage is by endless rope, the rope from the engine travelling over 8ft. pulleys fixed on head gear at pit mouth, and 504ft. down the shaft. It then passes under 8ft. pulleys fixed at the bottom, and passes over rollers along the roadways to a tension pulley at the bottom thereof, and back to the engine. The speed of the rope is 2½ miles per hour, and it passes under the tubs, which are attached equidistant, forty loaded ones passing up as forty empties are descending.

THE CLAIMS OF NAVAL ENGINEERS.

PUBLICITY has lately been given to a statement of claims purporting to be issued in the name of the naval engineers. It claims a fair variety of things—possibly on the principle that you should ask a deal to get a little—but there is one particular claim which overshadows all the others. We refer to the demand for combative titles, ranging from sub-lieutenant R.N.E.—the assistant-engineer of to-day—to rear-admiral R.N.E.—chief inspector of machinery. We can hardly believe that this claim represents the desire of the majority of our engineer officers. Such a plagiarism of the agitation recently carried on by the army surgeons can hardly, we think, be representative of the views of the whole body of naval engineers.

How can any man hope to better the condition of his profession, when he begins by publicly avowing that he is ashamed of it. The "R.N.E." means nothing; Captain Jones is Captain Jones, and outside service circles not one person in twenty can tell whether Captain Jones is a captain, commander, staff-commander, or lieutenant-commander, or, unless, perhaps, they saw him in uniform, captain of marines. Consequently, if the contention were granted, every commander or captain R.N.E. would be taken to be a captain in command of a ship. There may be some to whom these borrowed feathers may seem admirable, but such persons must be logical enough to drop all talk about the dignity of their profession.

The opponents of the claims of the engineers have all along and unanimously stated that the agitators cared little for the professional aspects of the question, but everything for the show part of the business. Some even prophesied a claim for executive titles. Now the demand for titles is published. It is impossible to conceive of a greater mistake; it is nearly as impossible to conceive how it could have been made.

The granting of the engineer demands depends upon the Admiralty, who are a stiff-necked generation. They come from the executive ranks, and hold executive views—"only more so." The opponents of any consideration to the engineer officers played their strongest card by appealing to the most jealous executive sentiment when they hinted that the engineers were title hunting. The ordinary executive saw no reason why the engineer should not have executive rank in his own department, even Admiralty objection to it was more mere conservative apathy than active objection. The looked-for change was almost on the eve of being secured. Now, every formerly apathetic opponent is converted into an active objector, and the field is opened to a most unpleasant state of affairs. Fortunately, on shipboard one hears but little of the fray; there is still peace. But the active pursuit of the claim for titles can only produce bad feeling and a state of open enmity—bad for the service, and worse than useless to the engineers, numbers of whom have little or no sympathy with the claims put forward.

Of the other claims, many of them more or less reasonable even in executive eyes, it is useless to speak now; the claims for titles swamps them. While the Admiralty is what it is, we much fear that the claim for fancy titles will produce an absolutely unyielding front.

We strongly advise naval engineers as a body to see that this claim for titles is withdrawn, if they wish to see the necessary demands granted. We would impress the same as strongly upon non-nautical engineers, many of whom have been breaking lances around a question, the inner parts of which they, by nature of being landsmen, are unable properly to comprehend. Arguments that to a landsman are unanswerable may, afloat, be too demonstrably weak and unsound to be worth a second thought. Service conservatism, service prejudice—these things are not the mere "sentiment" that so many are prone to consider them. The whole life in a man-of-war is a complicated piece of human machinery, and the so-called "mere executive prejudice" is an integral part of that machinery, actually essential to the proper working of other parts. There is nothing on land to liken man-of-war life to—it is a thing entirely apart. But, in the interests of the naval engineers as a body, and of the whole nation, it would be well if certain enthusiasts could be brought to realise that a failure to run properly of one part of some machinery is not to be mended by dropping grit into the bearings of another part. On both sides too much of this has been done.

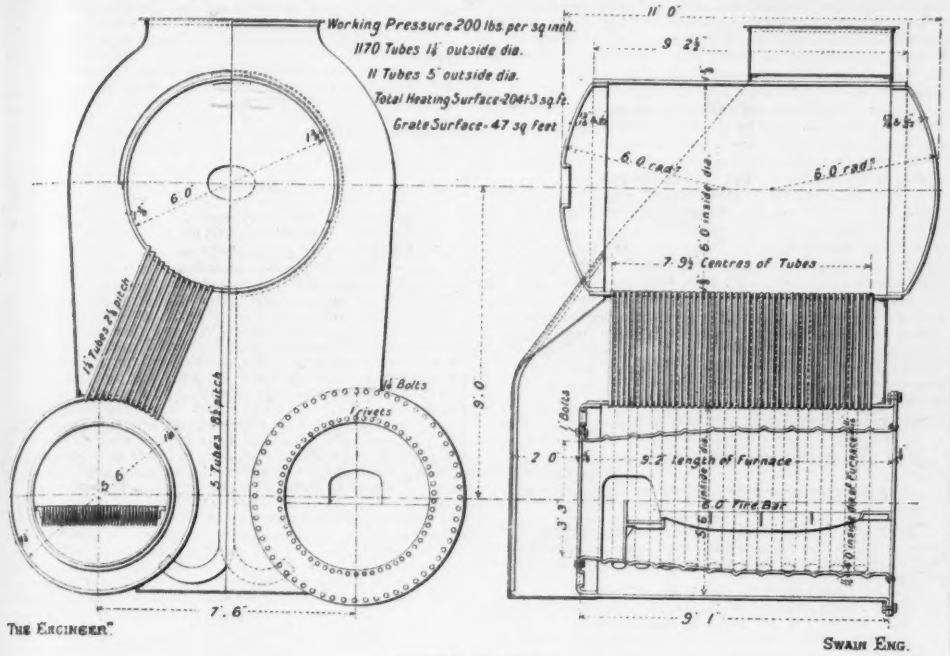
ARE THE SPANISH COLONIES TO BE LOST MARKETS?

NOT a little uneasiness is being exhibited in the Midland districts as to the probable effect upon British commerce of Spain practically ceasing to be a colonial Power. A very considerable business is done by Sheffield, Birmingham, and other Midland centres with the Philippine Islands, Puerto Rico, Cuba, and other places which are now passing from Spain. This business is mainly done through Spanish merchants, and as the latter have a well-deserved reputation for being good payers, even when the times are against them, it is only natural that British merchants should not want to lose the trade without a struggle. The first movement in the direction of attempting to retain these markets has been made at Sheffield. Mr. F. Brittain, the head of a well-known firm, has given notice of his intention to move at the annual meeting of the Associated Chambers of Commerce next March a resolution to the effect, "that a memorial be presented to the Prime Minister praying that her Majesty's Government will enter into friendly communication with the Government of the United States for the purpose of providing that the produce and manufactures of Great Britain shall not be subjected to differential customs and duties on their importation to the Philippine Islands, Puerto Rico, or Cuba." There is some reason for taking this action, for, although we hear a good deal of the policy of "the open door" in China being acceptable to the United States as much as to Great Britain, there is reason for doubt whether the United States Government intend to grant "the open door" at home. It was stated the other day by a leading London paper that the tariff to be enforced in the Philippines would bear equally on the importations of all nations, and that no advantage would be given to the products of any country, not even to those of the United States. An American correspondent, writing to London, put it in this way:—"We will collect the same duties upon our own imports as we will collect upon the imports of others." Later advices from New York represent the matter in a less favourable light. It is now stated that an "open-door" policy, as popularly understood, would, if carried out, be a violation of the constitution of the United States. Mr. Dingley, the framer of the last tariff, is quoted as saying, that "the proposition on this subject related only to such time as the islands might be under military control, leaving it for Congress to determine what should be done after such control might terminate." One difficulty, it seems, is in regard to sugar. It is alleged that in the new American possessions, with stable governments, and American capital and American supervision, their sugar production would be increased so enormously as to break down completely the beet-sugar industry, not only of the United States, but of the world, including the highly-protected and bounty-nurtured beet industries of Germany and other European countries. It is therefore far from clear as yet that anything approaching to the "open door" is to be granted by the States in their new possessions. Whatever may occur in regard to sugar, the hardware, cutlery, and kindred trades would feel very keenly the loss of business which would accrue if the Philippines, Cuba, and Puerto Rico were added to our lost markets. That would be rather a shabby return for the sympathy we extended to the United States in their successful struggle with Spain. That sympathy has already cost us the larger half of the Spanish market in Europe, and it would be doubly unkind if it were to lose us the whole of the business done with the Spanish colonies abroad.

AMERICAN RAILWAY TRAVELLING.—The first railroad was completed to Buffalo, on Lake Erie, the line from New York or from Boston consisted of six different roads, over each of which the passenger was obliged to purchase his tickets separately. There was then no system of checking or registering baggage, and it was transported wholly at the passenger's risk. The West-bound passenger left Buffalo on a steamboat or packet, and travelled to Toledo or Detroit, from which points ran stage coaches, landing ultimately at the then frontier point of Chicago. West of Chicago there were no public means of locomotion, except a few local stage coach lines reaching out to the new towns on the prairies and in the forests beyond. Even at that early period, when America was beginning to boast of its unexampled transportation facilities, it required about ten days to make the journey from the Atlantic Coast to Chicago, and there were three different means of transportation, the last of which was characterised by a degree of discomfort and of personal hazard scarcely to be imagined to-day. The limited trains of the trunk lines now cover the distance in twenty-four hours, and the traveller has scarcely a want or a desire, natural or artificial, unfilled. He sleeps, eats, reads, writes, smokes, amuses himself, transacts business, bathes, and is shaved with the utmost comfort and safety while speeding over the country at the rate of fifty miles or more per hour. So complete and so perfect are all the modern devices to ensure the safety and comfort of the traveller upon the great American lines that nothing more would seem to be left to be invented, devised, or applied to add to it or to reach ultimate perfection, says Mr. Frank J. Bramhall in *Cassier's Magazine* for December.

ASHBY'S MARINE BOILER.

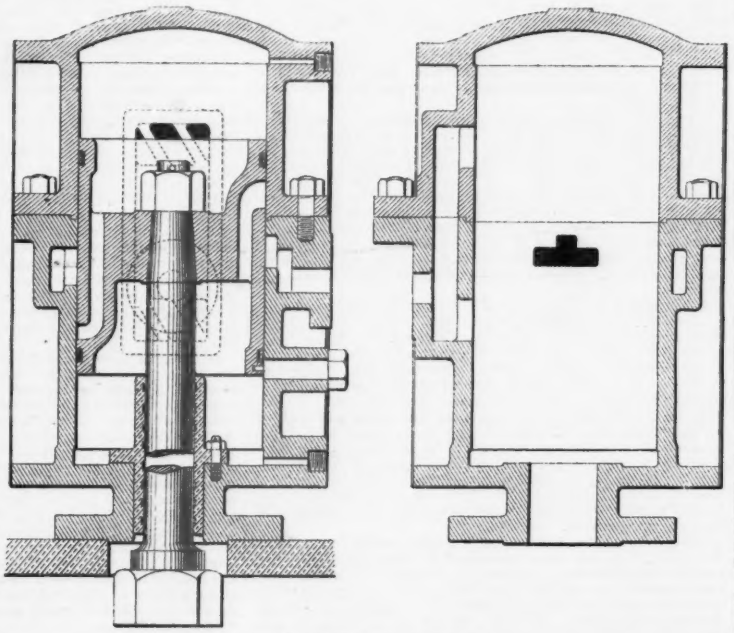
THE accompanying engravings illustrate a marine boiler invented and patented by Mr. J. A. Ashby, of Stratfield-street, Pallion, Sunderland. The drawing explains itself at a glance, and requires no description. Mr. Ashby, being a practical boilermaker, seems to have worked out all the details very carefully.



ASHBY'S BOILER

ASSISTANT CYLINDERS, H.M.S. SAPPHO.

TRIALS have recently been made on H.M.S. Sappho with a view to testing the value of Joy's patent assistant cylinders for relieving excentrics of trouble from heating and excessive wear. The engines in question are of 9000 indicated horse-power, with cylinders 33½in., 49in., and 74in. diameter, by 39in. stroke, running at 140 revolutions, and having a steam pressure of 155 lb. The high-pressure cylinders are fitted with piston valves, the intermediate-pressure and low-pressure cylinders have flat valves with a travel of 8in., and with balancing rings on the backs of them in order to relieve the pressure on the faces, and it is to these valves that assistant cylinders have been fitted. Balance cylinders of the ordinary form, open to the casing at the bottom and connected with the condenser at the top, were originally fitted; but these were found to be quite ineffectual in dealing with the enormous momentum of these valves, amounting in the case of the low-pressure engine to 850,000 foot-pounds per minute, and the excentrics were found to wear very rapidly, even in a short commission for the annual manœuvres. The alterations consisted in stripping the old balance cylinders, and fitting assistant cylinders of 9½in. diameter on the faces left, connected with boiler steam and exhausting to the condenser. The principle of these cylinders is now so well known that we need not describe it further, but in this case, owing to the very limited room available between the cylinder tops and the underside of the armoured deck, a special form of assistant cylinder had to be adopted, so that the long piston might be withdrawn for examination without breaking a number of joints. The illustration shows clearly how the bore of the cylinder is divided, part being in what may be called the cover and part in the cylinder proper. This, of course, requires careful fitting, but is the form commonly adopted in such cases, and has proved perfectly satisfactory in practice. The trials which took place at the Nore proved a great success, as the valve gears worked perfectly smoothly all through, and no water was allowed or required on the excentrics throughout the trial, and as this had always previously been necessary the cylinders must be admitted to have efficiently performed the work that was set them to do. This is the twenty-ninth ship of H.M. Navy which has had these cylinders fitted, but this is the first of them to which it has been applied to cure existing trouble, although we understand that in the mercantile marine it is quite a common practice.



JOY'S ASSISTANT CYLINDER

A PORTABLE ASPHALT PLANT.

THE introduction of asphalt paving into small towns, where the amount of work would not warrant the expenditure for the establishment of the plant required for preparing the asphalt, is being made practicable in the United States by means of portable asphalt plants. Each plant is contained upon two railway cars 40ft. long and 9ft. wide, the sides and roofs forming working platforms, and the chimneys, &c., being taken down and stowed away when the work is finished. These plants are built for paving contractors, and are hauled from place to place in regular goods trains, resembling ordinary box cars in appearance. Special attention is given to the compact and convenient arrangement of the machinery, and to securing such strength as to resist the shocks and strains of railway service without injury. The portable plants, designed by Mr. Frederick A. Hetherington and described below, have been used in several towns and transported for long distances by rail.

The underframes consist of six sole plates or longitudinals, composed of 12in. rolled joists and channels; these longitudinals support steel bolsters for the bogie trucks, and are floored over with riveted steel plates. The entire underframe is made rigid by eight lines of truss rods. The cars are built entirely of metal, and are fitted with air brakes and automatic couplings. Each car is carried by a pair of four-wheel bogie trucks.

Upon one car are assembled a boiler of 50-horse power, a steam engine of 35-horse power, a feed pump, two sand heating drums, an air compressor, and a double rotary air exhauster, used to create the artificial draught required for the fires of the sand drums. Upon the other car are established three or four air-tight kettles or tanks, each having a capacity equal to seven tons of melted asphalt. These kettles are encased in an exterior steel plate housing, but are separated by partitions of specially-designed fireproof tiles. The inside walls of the steel plate housing are also lined with these tiles, one inch of air space separating the tiles from the plates of the outer housing. The fire-places of the kettles are constructed entirely above the deck of the cars, the grate bars being set into the car floor, so that there are no parts projecting below the level of the floor. The hollow tile linings form excellent insulation against loss of heat, and at the same time are much lighter in weight than ordinary fire-brick. All of the tiling and masonry about the furnaces is so interlocked in the setting that it cannot become loose.

One of the most unique features of this plant is the central tower, which is constructed of comparatively light weight tubing and steel beams, being erected when the cars are in position on the site for their work. This tower is situated centrally between the two cars, which are placed end to end upon the tracks; it is connected to, or rather built upon, the adjacent corners of the cars. At a distance of about 9ft. from the ground the tower standards support a platform upon which is placed the asphalt mixer. This is the machine that mixes the required quantities of hot sand, asphalt, and carbonate of lime, that in combination form the material for pavements. Still higher in this tower is situated a rectangular steel box of considerable size, which is called the hot sand storage bin. Beneath this bin, and suspended just above the mixer, is the measuring box, containing the requisite amount of sand for one charge of the mixer.

Within the sand storage bin overhead is a revolving screen or sieve, to separate the gravel and coarser particles from the sand that is to be used in the mixer. Between the adjacent ends of the two cars, and beneath the mixer, is a passage way through which a wagon may be driven. The operation of the plant is described as follows:—Sand is shovelled from the supply pile into the buckets of the cold sand elevator, and by them is delivered into the sand heater, from which it emerges very hot, into the boot of the hot sand elevator. By the latter the sand is carried up into the revolving screen, where all gravel and coarse particles are removed, and it then falls into the hot sand storage bin, down through which it finally passes, by means of the measuring box, into the mixer. While this sand operation has been going on, the operator at the melting car has opened a valve in a large pipe which projects from the asphalt agitator, and has filled a steel bucket with a certain amount of asphalt. In this bucket the charge of asphalt is automatically weighed. As the operator at the mixer lets a charge of hot sand fall into the mixer, the melted asphalt is run from the agitator to the mixer on a short trolley, and is poured into the tumbling and tossing mass of hot sand, into which has previously been dumped the required amount of carbonate of lime. The whole batch is then allowed to mix furiously for a short period of time, when the operator at the mixer pulls a lever which opens a door in the bottom of the mixer, and the whole mass falls into a wagon which stands beneath to receive it.

The inventor had estimated for a working capacity of from 900 to 1000 square yards of pavement per day, but actual field work this season has demonstrated that the capacity is from 1800 to 2400 square yards per day. The plant is complete in itself. It contains all of the machinery that the paving contractor requires, excepting his steam roller and street tools. There are no sheds or buildings to erect, yet all parts are amply protected from rain and sun. At the end of the season's work the plant may be finally closed and locked, and may stand fully protected without other cover than is provided in itself.

APPARATUS FOR COILING LIFE LINES.

THE accompanying engravings illustrate an ingenious apparatus for coiling rocket lines. It has been patented by Mr. William Schermuly, 62, Stainsby-road, Poplar, rope splicer. Fig. 1 is a plan and Fig. 2 is an elevation. *a* is the bed or base-plate of the machine, and *b* is a rotary platform or plate mounted upon the bed or base-plate; *c c* are pins or pegs secured to the rotary platform; *d* is a second upper or auxiliary platform or plate provided with suitable holes to admit of the passage of the pins or pegs, and supported by nuts upon vertical screw-threaded spindles *e*. The spindles are mounted in the lower platform, as shown at and are fitted at their lower extremities with pinions, which gear with a toothed wheel secured to the base-plate.

Fig. 1

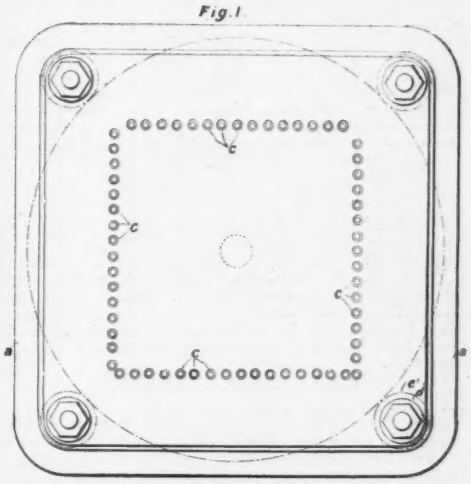
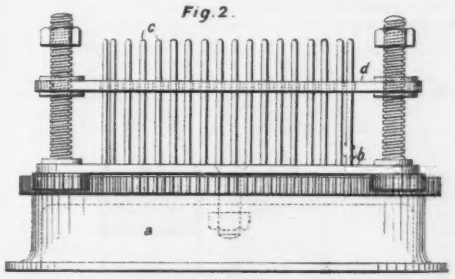


Fig. 2.



APPARATUS FOR COILING LIFE LINES

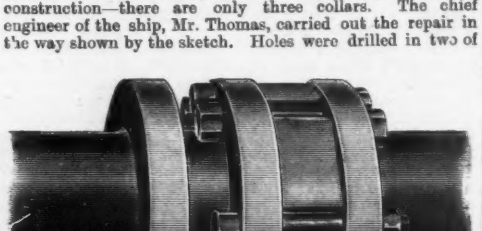
To employ the apparatus for coiling a line, the adjustable upper platform is first brought to within a suitable distance from the upper extremities of the pegs, and a piece of canvas placed thereon. The end of the line is then fastened to one of the pins, and the line is then coiled or passed round the pins or pegs in any suitable manner until the end of the two rows of pegs facing the operator is reached, and a layer of line formed. The platforms are then turned one-fourth of a revolution, so as to bring the other two sides thereof and rows of pins in front of the operator, and at the same time, through the corner screws, the second platform lowered a sufficient amount to take another layer, when the coiling of

the line is proceeded with in a similar manner upon the pins or pegs. These operations are repeated until the upper platform has been moved to its lowermost position and the whole length of the pins filled. The coiled line is then removed from the pins or pegs, and placed in a box or case provided for its reception, the piece of canvas or other material facilitating the operation. This box or case is thus filled with a compact mass of line.

By this apparatus it is possible to wind or coil a line of great length into a very confined space, and in such a manner that the line will run out at a high speed without becoming foul, as, for instance, when employed as a life line in connection with rockets and the like. The long lengths of coiled line, moreover, stowed in boxes or cases in the manner described may be roughly handled and packed in any position without any danger of the line becoming entangled, and they are in a very convenient and portable form for transport.

REPAIRING A SCREW SHAFT.

THE accompanying engravings illustrate a very clever repair of a propeller shaft effected in fifty-one hours by the aid of "Atlas" metal. The ship is the Royal Prince. The shaft broke in the thrust block, which it will be seen is of unusual construction—there are only three collars. The chief engineer of the ship, Mr. Thomas, carried out the repair in the way shown by the sketch. Holes were drilled in two of

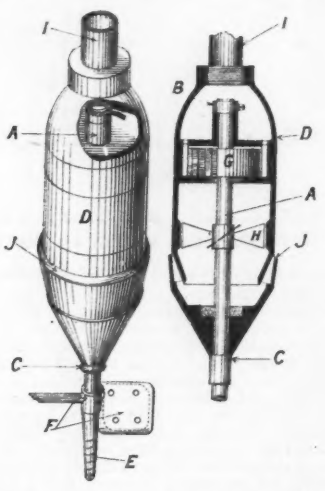


the collars, and through these bolts were passed, as shown by the perspective view. These bolts could obviously have been twisted across, unless some means were devised for putting them in shear. This was done by running in "Atlas" metal, to fill the gap between the end of the fractured shaft, and to form a ring round the joint.

The thrust was exerted in the direction of the arrow by the forward collar A, and by it alone. The repair was so successful that the ship steamed 180 miles to Alexandria at half speed. All the "Atlas" metal in the ship was used up; if more had been available Mr. Thomas would have cast a collar round the shaft at B so as to cover the heads of the bolts, and then by shifting the thrust block shoe he would have been able to go astern, which, as it was, was impossible.

MACHINE FOR DRIVING PILES IN HEAVY GROUND.

A NEW boring and pile-driving machine for use in quicksand and heavy ground has been recently used on Canadian Government works at Owen Sound, and other places. In the accompanying view, A is a hollow vertical shaft, supported by



collar bearings B and C in the sectional casing D, which is made up of cylindrical and conical sections screwed together. On the end of the shaft is cut a screw thread of coarse pitch E, and above this is a double-bladed cutter F, the blades of which are so set as to raise the material through which they cut. These blades are detachable, so that they can readily be renewed when worn out on requiring to be sharpened. On the shaft, and within the casing are a horizontal turbine G and a horizontal propeller screw H. A pipe I supplies water from a force pump to the machine, and the machine is raised and lowered by any suitable means, as for raising and lowering the pipe used in sinking piles by the water-jet system.

Some of the water which enters the casing under pressure passes down through the hollow shaft and escapes at the bottom, loosening up the soil. The pipe will not carry away all the water, however, and a portion enters the wheel chamber, and drives the turbine, thus revolving the shaft and its cutters. After passing into the lower part of the casing, the water from the turbine is forced out through the annular passage J, aided by the screw, and serves to raise and wash away the material loosened by the cutters. The size of the casing D is slightly less than that of the pile.

On the harbour work at Owen Sound, built by the Department of Public Works, considerable difficulty was experienced in driving piles by an ordinary pile driver, owing to the compact material encountered. A fender pile of rock elm, 12in. square, and 40ft. long, driven by a 2000 lb. drop falling 20ft., and pointed and ringed with iron, split below the ring after 200 blows given in thirty-five minutes. The head was cut off and the ring replaced, but after fifteen strokes the pile could not be driven further, though 3½ft. above its proper position. With the Canan boring machine eighty to a hundred piles of the same size, penetrating 20ft., were set in ten hours. At first the pile hammer simply rested on the head of the pile, but to settle it to the full depth a few blows were given, the hammer, however, having a drop of only 2ft.

CHEMICAL FIRE EXTINGUISHERS.*

THE ancient Greeks, in order that the burning arrows of their enemies might not consume their wooden defences, used alum to coat all exposed woodwork, and prepared alum solutions for fire-extinguishing purposes.

During the great fire in London in 1666 it was noticed that on exploding a large quantity of gunpowder to destroy a building in the path of the fire, all flames in the immediate vicinity were extinguished. Bombs containing inflammable chemicals known to give off stifling gases, provided with an igniting fuse, and intended to be thrown into a burning building, were used early in the eighteenth century.

In 1715 an extinguishing apparatus was devised, consisting of a cask of water in which a can of gunpowder was suspended in such a manner that on placing the apparatus in a burning room and exploding the gunpowder by means of a fuse, the water would be thrown in all directions, and, together with the dense gunpowder smoke, would extinguish the flames. Hollow clay or glass balls filled with finely-powered alum, and containing a charge of gunpowder arranged to be ignited by a fuse, and intended to be thrown into the fire, were used as early as 1770.

From early in the present century, when the fire-extinguishing qualities of various chemicals became better known, up to the present day, a large number of so-called fire-extinguishing solutions and compounds have been from time to time brought to the attention of those interested in extinguishing fires. The claims made by the various inventors and manufacturers of such devices seem to be stereotyped, those nearly one hundred years old reading the same as those of to-day. The description of fire tests made to demonstrate the value of the earlier devices vary but little from those reported in the newspapers of the present time.

The early inventors also knew that mysterious and secret compounds for fire extinguishing purposes would be bought by the general public at many times their intrinsic value. While hundreds of compounds and devices have been "invented" (!), few, if any, have succeeded in demonstrating their value, and of obtaining a foothold among the fire-extinguishing apparatus of our fire departments.

It may be well at this point to consider the term "invented" as applying to this class of chemical extinguishers. As the chemical salts and gases with fire-extinguishing properties are well known, the "invention" of a new chemical with these properties is out of the question. The "inventor" of fire-extinguishing powders or solutions is restricted to compounding mixtures from the following list of chemicals, whose properties are well known, viz:—Alum, soda, borax, hyposulphite of soda, silicate of soda—water glass—chloride of lime, tungstate of soda, chloride of tin, sulphate of ammonia, chloride of ammonia, sulphate of soda, nitrite of soda, chloride of sodium—common salt—potash, bicarbonate of soda, and ammonia.

The process of inventing a chemical fire-extinguishing compound, is therefore the question of a short time. As an example of this class of chemical fire extinguisher, I will ask you to recall the advent of the "hand grenade." The millennium had arrived; no more conflagrations were possible. Fire tests, such as described further on, were made in every city and village; thousands of glass bottles, filled with an inexpensive saline solution were sold at many times their value; the papers were full of cases of fires extinguished by hand grenades. The claim that a substance had at last been found which, thrown into a fire at its incipiency, generated a gas and promptly extinguished the flames, seemed to be substantiated. The burning of a warehouse containing a very large number of hand grenades on storage in this city, however, demonstrated very forcibly that the extinguishing gas supposed to be generated by heat, did not generate.

It is not the object of this paper to discuss in detail the value of the various chemicals above mentioned, but to describe briefly the principle and construction of the only chemical fire extinguisher which has won a permanent place among the apparatus used by organised fire fighters throughout the world—namely, the carbonic acid gas extinguisher. The first carbonic gas machine was constructed by Charlier and Vignon, in Paris in 1864, and excepting that tartaric acid powder used to liberate the carbonic acid gas from the bicarbonate of soda solution was soon replaced by sulphuric acid, and that the construction, providing for the liberation of the carbonic acid gas on closing the cylinder and the maintenance of a constant gas pressure was soon discarded, there has been no change in the principle of this class of apparatus.

The apparatus is well known. It consists of a cylinder, usually of copper, which, as the pressure of the gas generated therein reaches about 125 lb. per square inch, and which under certain conditions may largely exceed this, for safety must be strong enough to stand from 300 lb. to 500 lb. pressure to the square inch. The cylinder is closed by a screw cap, and provided with an outlet to which a short piece of hose is attached. A short metal nozzle, usually of lead or an alloy of lead, is attached to the hose. A stop-cock to shut off the chemical fluid may or may not be used. The chemicals used are bicarbonate of soda, dissolved in water of sufficient quantity to fill the cylinder, and sulphuric acid, which latter is contained in a glass bottle inside the machine, so arranged that when to be used the bottle is either reversed or broken, discharging the acid into the soda solution, generating carbonic acid gas.

The various extinguishers now in use differ principally in the method of storing the sulphuric acid, and in the method of mixing the acid with the soda solution. Without going into details as to the mechanical construction, I will briefly describe the simple chemical reaction which takes place in all extinguishers of this class.

When sulphuric acid is mixed with bicarbonate of soda dissolved in water, the sulphuric acid at once combines with the soda of the bicarbonate of soda, forming sulphate of soda and liberating carbonic acid gas in great volume. The value of the apparatus is due to this chemical action. Both the soda solution and carbonic acid gas are of value as extinguishing agents, although I believe that, except in cases of very close application to the fire, or in confined spaces, the carbonic acid gas is valuable more as a propelling agent for the soda solution than as an extinguishing agent.

The proportions of the chemicals are so arranged that the amount of bicarbonate of soda is largely in excess of the amount necessary to take up the quantity of sulphuric acid used. This is done that the solution ejected from the extinguisher may be alkaline and prevent free acid from doing damage; and, secondly, to make the resulting soda solution as strong as possible.

As above stated, I believe that the soda solution in most instances is of more value as an extinguishing agent than the carbonic acid gas. I base this assertion on the fact that, when the stream from a chemical extinguisher is thrown on the fire from a distance, the larger quantity of the carbonic acid gas is dissipated.

As carbonic acid gas acts solely by exclusion of the air necessary to support flame, and as the proportion of carbonic acid gas necessary to render the air in a certain space a non-supporter of flame is about 10 per cent., in large open rooms, or in the open air where confining the gases is impossible, carbonic acid gas, excepting it be used in exceedingly large quantities, is of little avail. The value of the carbonic acid gas extinguisher depends largely on the fact that the soda salts are very soluble, and that a saturated solution of it when thrown on the fire at once coats the burning substance with a crust of incombustible soda salts, thereby preventing the spread of the fire. It is due to this fact that chemical fire buckets, syringes, and the tin tube extinguishers, have in some cases been of value, as a soda solution of some kind is usually the chemical this class of extinguishers contains. It is safe to assume that the claim made that this latter class of chemical extinguishers, extinguished flames by means of a gas generated from the chemicals they may contain, when thrown on the fire, is not entirely borne out by the facts. I do not wish to be understood to say that a gas which does not support combustion cannot be used to put out a fire under certain conditions; but the conditions in actual practice do not warrant the claim made for the so-called chemical extinguisher. The value of extinguishers of this class is further reduced by the fact that, in order to be at all effective, it is necessary that they be used on the flame at close quarters, which in most fires is impossible on account of smoke.

Chemical extinguishers without carbonic acid gas, and using compressed air as a propelling force, have been on the market for some time. The effectiveness of this class of extinguishers is, however, reduced by the fact that it appears difficult to construct an apparatus which will permanently hold air under pressure.

In 1881, a patent was issued to a man named Raydt, for an apparatus for extinguishing fire, consisting of a large cylinder for water and a smaller one for liquefied carbonic acid gas. By opening a stop cock the liquefied gas was introduced into the water cylinder, so that carbonated water at great pressure was at once available. While this apparatus was of good extinguishing effect, it never came into general use. Stationary cylinders of liquefied carbonic acid gas should, however, be of value for extinguishing fires in confined spaces containing inflammable substances—for instance, coal bunkers of vessels, holds of vessels, cotton-ware rooms, &c. Oil tanks could be very successfully protected by a device arranged to discharge carbonic acid gas over the surface of the burning oil.

Returning to the question of extinguishing fires by means of gases generated from chemicals thrown into the flames, I am of the opinion that this claim is largely due to the fact that so-called fire tests of fire extinguishers are generally arranged to prove this claim. In the stereotyped test of this kind, a large wooden box carefully placed, with reference to the direction of the wind at time of test, is partly filled with strips of wood, Excelsior, and other inflammable material treated to a liberal allowance of coal oil, turpentine, or tar. The application of the liquid from the extinguisher being tested is made to the base of the burning mass, apparently that the gas generated from the chemicals may rise and extinguish the flame. Some gas, if the heat is great, is undoubtedly liberated, and has some effect on the flames. The fire, however, is usually extinguished by the coating of the burning substance with a soda salt, thereby preventing the generation of combustible gases.

It is found that in such tests the oil used, after having the desired effect of creating a very large and fierce flame, has been entirely consumed. I recall a test of a chemical extinguisher where the regulation test was made as follows:—A large piano box with one side removed and set on edge was partly filled with strips of wood and Excelsior liberally treated with coal oil; the upper portion of the box was painted with a tarry mixture. When ignited the flame shot up 20ft. or more. With one application of the extinguisher the flame was extinguished, the oil and tarry paint having been entirely consumed and the wood only slightly charred.

In order to show the value of the extinguisher being tested, the inspector of the local Underwriters' Association present arranged the test as follows:—A wooden box constructed to resemble a wardrobe in a dwelling, but without doors, was filled with old clothing, both cotton and woollen, suspended from a shelf, additional clothing being piled on a shelf, no oil or other inflammable matter being used. When the clothing was ignited and the fire well under way, the expert of the extinguishing company present was directed to attack the fire. About a dozen extinguishers were used at very close quarters without having a very decided effect on the fire, which was not extinguished until the clothing had been consumed. While one extinguisher was sufficient to extinguish a fire, with flame nearly 20ft. high, the attempt to extinguish burning clothing in the open air, where it was possible to fight the fire at close quarters, proved a failure. If the burning clothing had been in a room with no chance for the stifling smoke to escape, the result would necessarily have been even a greater failure.

It has been claimed by some that ordinarily a fire-extinguisher containing chemicals in solution is valuable only to the extent of the water contained therein. A recent test of a chemical attachment to fire-buckets seems to substantiate this claim.

In all large cities where carbonic acid gas extinguishers are a part of the regular equipment of the fire department, either as portable extinguishers in connection with patrol wagon or hook-and-ladder companies, or as chemical engines, the results achieved are very gratifying. In Philadelphia during the years 1896 and 1897, fully 25 per cent. of all fires were extinguished by chemical engines. In Chicago the percentage is even larger. In suburban towns, villages, and isolated country properties, a chemical extinguisher, either portable or on wheels, is of greater value than all other apparatus. In answer to queries sent to chiefs of fire departments throughout the United States, it is shown that in various cities from 25 to 80 per cent. of all fires were extinguished by carbonic acid gas, without the use of water.

Now that automatic fire-alarms are coming more generally into use, both in cities reporting to a central station, and in isolated risks reporting to the house of the manager or superintendent, so that a fire can be attacked in a very short time after starting, the carbonic acid gas extinguisher quickly handled, effective in its work and causing the minimum damage to property by reason of water used on the fire, is of the greatest value.

Unfortunately, there is a limit to the effectiveness of chemical fire-engines when called upon for use in our modern "sky-scrapers," or tall office buildings. A stream from the chemical engine on the

* Abstract of a paper by C. A. Hexamer, read at the annual meeting of the National Fire Protection Association, at Chicago, U.S.A., in June.

pavement can only be carried to a height of 130ft. to 150ft. It is therefore desirable to provide stationary or portable extinguishers for use in the upper storeys of our high buildings. Stationary carbonic gas engines so arranged that they are available at any storey have come into use, and for high office buildings are undoubtedly of great value.

An automatic carbonic acid gas sprinkling device has also been proposed, but has not as yet been put into practical use. The same may be said regarding a device providing for the discharge of both carbonic acid gas and ammonia gas stored in liquefied state, and released automatically in case of fire. While experiments have been made with these devices, they have not had the actual fire test. It has also been suggested that the stream from the ordinary steam fire-engine be charged with a fire-extinguishing salt on its way to the fire, an apparatus for this purpose has been constructed and tested, but has not as yet been perfected.

A carbonic acid gas machine arranged to discharge dry carbonic acid gas or a chemical steam, and intended for use on electrical fires, when it is desirable to extinguish the fire without the use of water, has recently been brought to my attention.

Underwriters' associations, with their usual conservative and careful consideration of new devices, have been very slow in recognising the value of the carbonic acid gas machine, preferring to make allowances for water buckets. A few associations have taken action and recognised one three-gallon extinguisher as the equivalent of six water buckets. This attitude of the underwriters is largely due to the usual apathy of the general property owner to the care of fire-extinguishing devices, after they have had the desired effect on his rate of insurance. A chemical fire-extinguisher to be of value must be periodically examined to determine whether it is in working order, and at least once in every six months should be discharged and re-charged. The cost of re-charging a three-gallon extinguisher is about 3½d. Discharging the extinguisher at stated intervals also familiarises the employés with its use.

Chemical fire buckets, being ordinary fire buckets filled with water in which one or more of the chemicals mentioned are dissolved, and provided with a paraffined paper or sheet lead cover, easily broken, have been in use for some time in factories and other risks, and have given fairly satisfactory results, as they could not be used for other purposes than for extinguishing fire, and as they needed less attention than ordinary buckets.

In practice I have frequently recommended the use of barrels of water in which a quantity of lime has been slacked, and in which a considerable quantity of common salt had been dissolved, as a very efficient fire-extinguishing liquid for use with the ordinary fire bucket. This solution does not readily freeze in winter or foul in summer, and can therefore be kept for a long time.

What to consider a satisfactory fire test of a chemical extinguisher is difficult to decide. The regulation tests known to all are of little or no value, as they present but one kind of fire, and that the most easily extinguished. The only practical test I can recommend is to place the extinguisher to be tested in the hands of experienced firemen connected with some city fire department for general use. If after a trial of six months or more the extinguisher has shown good results, not only as to fire-extinguishing qualities, but also as to general conditions, such as deterioration of contents, corrosion of vessel containing the extinguishing fluid, &c., it may merit more careful consideration by the fire insurance engineer. The question of preparing a specification for a standard chemical fire extinguisher is one well worth a special committee of this association, and in my estimation such an apparatus must be a carbonic gas extinguisher.

THE INSTITUTION OF CIVIL ENGINEERS.

VENTILATION OF TUNNELS AND BUILDINGS.

AT the ordinary meeting on Tuesday, December 6th, Mr. W. H. Preece, C.B., F.R.S., President, in the chair, the paper read was on "The Ventilation of Tunnels and Buildings," by Mr. Francis Fox, M. Inst. C.E.

In regard to the first part of the subject, the author enunciated the proposition that if the amount of carbon dioxide in the air of a railway tunnel did not exceed twenty parts in 10,000, then the ventilation might be deemed satisfactory. On this basis, and allowing twenty-nine cubic feet of poisonous gas for each pound of coal consumed in a locomotive, the number of pounds of fuel consumed per mile, multiplied by 29, multiplied by 500, and divided by the number of minutes interval between the trains, would give the volume of air which must be introduced into the tunnel per minute. The ventilation of the Severn and Mersey tunnels had been determined by this rule, and had been referred to as satisfactory in the report of the Departmental Committee of the Board of Trade on the Ventilation of the Metropolitan Railway Tunnels, 1897. In regard to the Mersey Tunnel, it was, however, to be regretted that, owing to the poverty of the company, inferior coal was being used, and the fans were run at a lower speed than was intended. Even with these drawbacks, however, the purity of the air in the Mersey Tunnel was well within the limits proposed by the author. The case of the Metropolitan Railway tunnels, having been the result of recent investigation, was not mentioned otherwise than to recall the fact that the amount of carbon dioxide in the air had been shown to be as much as 86 parts per 10,000. The great Alpine tunnels were next referred to. In the case of that under Mont Cenis, 8½ miles long and 26ft. wide, the higher altitude of the middle of the tunnel above its entrances was inimical to good ventilation, and at times great difficulty was experienced in carrying on the traffic. The antiquated system at present employed was merely palliative, consisting in the injection of only 70 cubic metres per minute of air compressed to 75 lb. per square inch, discharged at points one kilometre apart throughout the tunnel. Owing to the bad ventilation not only were the men working in the tunnel subjected to great discomfort, but the corrosion of the rails was excessive, about 300 tons having to be re-laid every year. The St. Gothard Tunnel, 9½ miles in length and 26ft. wide, was nearly level from end to end, and until recently, natural ventilation only sufficed, but, owing to increase of the traffic and the use of briquette fuel, the Saccardo system had lately been introduced. This consisted in blowing into the mouth of the tunnel a large volume of air which, on the principle of the injector, caused an induced current in the annular space between the interior surface of the tunnel and the gauge of maximum construction. This system had been adopted with success in the case of the Pracchia Tunnel on the main line between Florence and Bologna, the state of which was recently dangerous to human life. Experiments made by the author in this tunnel showed the following results:—Before starting the fan the tunnel was filled with a dense volume of smoke from end to end, the temperature being 107 deg. Fah., with 97 deg. of moisture, or nearly complete saturation. With the fan running the thermometer indicated 80 deg. Fah.—the temperature of the external air—and the moisture was normal. The volume of air injected by the fan was 164,000 cubic feet per minute, and that by the induced current 46,000 cubic feet, making a total of 210,000 cubic feet of air per minute passing through the tunnel. It was not improbable that the Saccardo system would be selected for the ventilation of the two parallel tunnels 12½ miles long, now being constructed under the Simplon.

Proceeding to consider the ventilation of particular public buildings, the author illustrated his views by reference to special cases which had come within his experience. The fact should not be lost sight of that the air in a room might be quite cold and yet very foul; whilst, on the other hand, it might be warm and yet perfectly fresh. To avoid draught, the air should enter through a large number of small orifices so as to thoroughly diffuse the current. This was done by gratings, but unfortunately these seriously diminished the volume of air passing through, owing to the friction of the bars. The same remark applied to extracting flues. The author was of opinion that no large building could be successfully ventilated without some mechanical force furnished by steam, electricity, falling water, or other such agency. Then, fans could be worked with certain results, whereas automatic extractors not infrequently became inlets, thus reversing the whole system. The inlets should be by Tobin or similar tubes, about 5ft. above the floor. In one American State Legislation building the warmed fresh air entered on the level and in front of the desks of each member.

In conclusion, the author urged the desirability of educating the public to the value and merits of fresh air.

MANCHESTER ASSOCIATION OF ENGINEERS.

THE annual general meeting of this Association was held on Tuesday, and there was a large attendance of members. Mr. Henry Webb, the retiring President, was unanimously re-elected for the ensuing year, and other officers were appointed as follows:—Treasurer: Mr. James Walthew. Trustees: Messrs. G. Carter, T. Ashbury, J. West, S. Dixon, and Sir William Bailey. Members of Committee of Management: Messrs. W. Fox, J. Saxon, and W. Smith. Auditors: Messrs. J. W. Eves and Glennie. Secretary: Mr. Frank Hazelton. Librarian: Mr. Robert Gass.

Discussion was then taken on several topical engineering questions submitted from the chair. The first question dealt with was, "Tool Rooms, their Advantages and Disadvantages." The President said it was almost the universal practice in American engineering works to have a portion of the establishment set apart as a tool-room. Mr. Wicks remarked that in the works with which he was connected they had tool-rooms in which they kept not only their tools, but their blue prints, and they had found it a great advantage. Mr. Hans Renolds gave some particulars as to the tool-rooms at Messrs. Brown and Sharp's works in the United States. Out of 1600 or 1800 workmen employed at the above establishment more than half were employed in the tool rooms. The American tool room was a result of the greater division of labour, the higher organisation of their engineering works, and the system of specialisation adopted by American firms in connection with the work that passed through their hands. Mr. Hodgson remarked that a tool room was, no doubt, of great advantage for repetition work; but how were they going to adapt it to engineering establishments where there was a great variety of work, and they never knew what would be the next job that would have to be done. Mr. Wicks said that the only course in such cases was to go in for making a speciality of one thing, and not try to do everything.

The second question was, "Can the use of machine tools in engineering works be carried too far, so as not to be economical?" Mr. Hodgson said the answer depended upon circumstances, principally upon the kind of work done. In connection with the manufacture of locomotives, engineers' tools, marine engines, comparatively small machines, or machines made to standard sizes, it was scarcely possible to carry the use of machine tools beyond the economical limit. On the other hand, in many general engineering works the use of machinery could, in his opinion, be carried beyond the economical limit. Mr. Nasmith thought the question ought rather to be, "Can the use of special machine tools be carried too far?" Where they had a large number of things to produce from one pattern, day after day, week after week, the use of special tools generally became the cheaper way of working; but even in repetition work there were cases where it did not pay to buy special machines, as they could do the work quite as economically with their ordinary tools by the aid of jigs, &c. It was quite obvious there were cases where the use of special machines was an advantage, and others in which, economically, it was a disadvantage. Mr. A. Saxon said his experience was distinctly in favour of extending the use of special tools in engineering works.

The last question submitted was, "Is there any gain in economy by heating feed-water with live steam from the boiler, and how can this be accounted for?" Mr. Ingham said this question had excited considerable attention, particularly amongst marine engineers, and it had been found about six years ago that in marine boilers, live steam heating not only prevented leakage, but also produced a considerable gain in economy. If it was true that live steam could be used with economy, there was room for further economy in land practice. Different theories had been raised to account for this economy. He did not think it could be accounted for by thermodynamic considerations. Mr. A. Saxon thought the explanation lay in the latent heat of the steam. Mr. Etchells expressed the opinion that it came to a question of maintaining the average condition of the boiler undisturbed. Mr. Boswell said the economy from heating by live steam had been known for nearly thirty years to locomotive engine drivers. He should personally attribute it to the better equilibrium in the boiler itself.

HYDRAULIC SHIELD TUNNELLING IN MELBOURNE.*

By GEORGE HENRY DUNLOP, C.E.

THE writer has chosen hydraulic shield tunnelling as the subject for this paper because it is the most important of the methods of tunnelling of which he has experiential knowledge, because the subject has not yet been written upon in relation to Victorian works, and because it is a process by which extended and varied work has been done here, and by which most important and valuable services have been rendered. The shield tunnelling carried out in Melbourne is no able no account of the number of sewers of small diameter built in this way, for the novel methods adopted for lining the tunnels, and for the variety and extent of the soft ground to be passed through.

The descriptions and particulars given are taken mainly from Melbourne sewerage works and from the writer's own experience. The source of the information is given in all other cases.

The importance and success, indeed—almost it might be said, the necessity—of this system for carrying out the tunnelling for the Melbourne sewers, is manifest to everyone having knowledge of what has been done. The extent of Melbourne shield work is indicated by the following list, and it is safe to say that were the whole of the sewerage works to be carried out with present knowledge, this list would be much longer.

The first introduction of the shield in Victoria was for the purpose of constructing the Hobson's Bay main sewer with cast iron lining, under the Yarra at Spottiswoode, but the first shield tunnelling was done with concrete block lining at Port Melbourne.

The shield.—The shield consists generally of an iron cylinder about four to five times the length of the lining rings to be used with it. There is a diaphragm, or bulkhead, fixed in it at some distance from about 1ft. to half the length of the shield from the forward end, having one or more openings in it fitted sometimes with drop or sliding doors. In front of the bulkhead there may be horizontal and vertical longitudinal partitions forming compartments into which the soil is forced when the shield is shoved forward. Behind the bulkhead around the shield are fitted hydraulic jacks, the piston heads abutting on the end of the already constructed tunnel. By these the shield—of the various types of which illustrations will be given later—is forced forward after the rings have been built within the rear end of the shield.

The operation and suitable construction of the shield may be described for hard ground, wet silt and sand.

In hard or firm ground the bulkhead will be placed near the cutting edge and the ground will be excavated for about an average distance equal to a ring length ahead of the shield, the ground being taken chiefly from the centre of the face. When the shield is shoved forward, the cutting edge will break down a large amount of the ground ready for shovelling. A large door in the bulkhead is advisable. In work here in silt there has been no apparent advantage in having the bulkhead far from the cutting edge, but in the larger shields partitions in front are advisable, especially in soft silt, in order to control the "face." The shield will be shoved into the ground and the spoil shovelled as it squeezes up to or through the doors. The silt has been pressed, sausage-like, 2ft. from the doors of the shield with the bulkhead 4ft. from the front. Soft ground, such as sandy clay with water, will squeeze similarly, though not so freely as soft silt.

Contract.	Lining.	Diameter of sewer Intl. Extl.	Length of rings.	L'gth in feet.	Length of work done in compressed air in feet.
		ft. in. ft. in.	ft. in. ft. in.		
Hobson's Bay Main sewer	cast iron	9 0 11 0	1 6 2 9	900* 683	500 very short length
Sec. 1 Hobson's Bay	concrete blocks	4 6 11 0		1309	
Main sewer		3 9 11 3	1 6½	4900	nil
Sec. 2		9 0 11 6		3000	
Hobson's Bay Main sewer	concrete blocks	8 0 10 6	1 6½	960	700
Sec. 3 Hobson's Bay	cast iron	4 3 5 9	1 3	2070	1430
Main sewer	bluestone	4 3 5 10½	1 6½	1290	nil
Sec. 4 Hobson's Bay	bluestone	4 3 5 10½	1 6½	1327	nil
Main sewer	cast iron	4 3 5 9	1 9	1611	1485
Sec. 5	bluestone	4 3 and 5 5 10½ 8½	1 6½	1200	nil
South Yarra Main sec. 1	bluestone	6 9 9 0	1 6½	1760	nil
Richmond main Sec. 1	cast iron	4 3 6 0	1 6	704	494
Melbourne main	cast iron	3 3 5 9	1 6	1440	400
Sec. 1	cast iron	3 3 4 10½	1 to 2 varying	3440	nil
Melbourne main	concrete blocks	3 3 5 9	1 6½	860	nil
Sec. 1a North Yarra	cast iron	3 3	2 7	247	247
Main Sec. 1	bluestone	8 6	2 4	496	nil
	cast iron	8 6	1 6	387	
North Yarra Main Sec. 4	cast iron	7 9 9 9	2 0	80	probably nil
North Yarra Main Sec. 5	cast iron	7 9 9 9	2 0	5280	nil
North Yarra Main Sec. 6a†	wood	7 6 10 6	2 0	1270	nil
		6 9 9 9	2 0	1990	
			Total length	37,145	

* Section under Yarra. About 560ft. subaqueous.

† Alternative tenders called for wood and cast iron lining. Tunnelling nearly completed.

The most difficult material to deal with is fine running sand, especially if there be hard material in the bottom through which the shield cannot be forced. It is impossible to force the shield through sand as through silt without undue pressure. The face must be excavated back. Unless the pressure of the water is so great that compressed air is necessary or at least distinctly advisable, it is not difficult to excavate out as far as the front of the shield. There should then be sufficient room in the compartments to hold the spoil for the shove for a ring length. When working in this way the ring length should be short—not more than 18in. In the Graham-street shield tunnelling at Port Melbourne, the shield—Fig 2—was 8ft. long, 10ft. 9in. in diameter, with the bulkhead in the middle of the length. There were four compartments and plates tapering from the full diameter at the edge, to about 6ft. diameter at the bulkhead, where there were four openings each about 2ft. square fitted with drop doors. Drop planks fitting in channels beside the doors would be about as effectual as the doors, and would permit a larger and more convenient opening. This type of shield was most effective in compressing the silt, but the sand would not compress. The conical form of the front compartments presented too much resistance to the shield, and required more compression than could be obtained except with silt. And although the chambers 4ft. deep might be full of sand, at times the water would rush through, carrying slurry. Finally it became necessary to employ air pressure to enable the chambers to be properly cleared. The distance of the bulkhead from the front of the shield was then found to be a source of considerable inconvenience when excavating. The rings were 18in. long, and when shoving in the running sandy ground, and especially before compressed air was used, extreme difficulty and great delay were continually experienced in pushing the shield through the last few inches. Frequently the chambers were cleared twice for each ring length, and sometimes it was necessary to clear them to allow the shield to move the last one or two inches. For a considerable distance here, there was a layer of about 2ft. of cemented gravel in the bottom with silt and sand above. The horizontal front partition was kept pressed into the face, and, notwithstanding the running ground in the top of the excavation, the men were able to go safely under the partition so as to pick down the gravel in front of the cutting edge.

For use in cases where variable ground will be met with, every shield large enough to allow subdivision of the front into compartments should be arranged so that partitions and doors can be bolted in and removed at any time. Thus the Greathead type of shield used for the Yarra Tunnel at Spottiswoode was subdivided in front into four compartments in this manner, by the second contractor, and the partitions were removed when the tunnel had been carried forward some distance into firm clay. There was considerable inconvenience in working with them; and they possibly were at no time entirely necessary. They doubtless gave a feeling of security to the workmen.

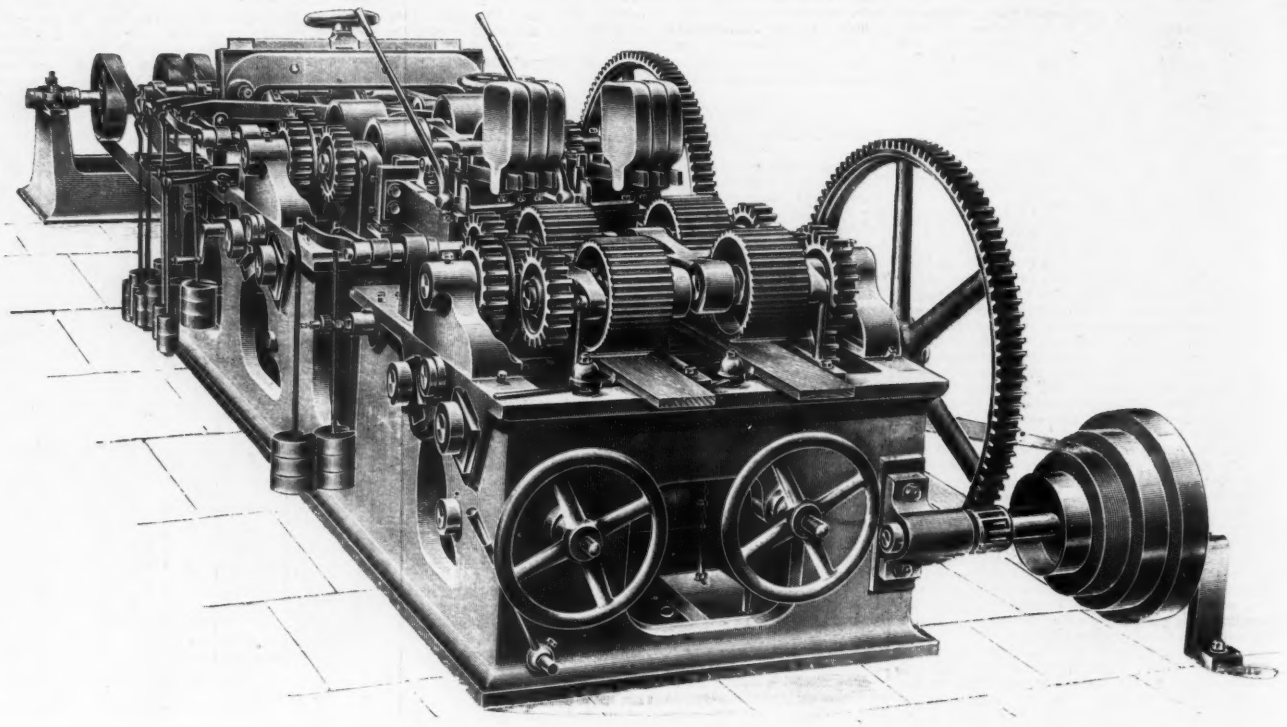
(To be continued.)

* Read before the Victorian Institute, August 3rd, 1898.—Slightly condensed.

WATER-TUBE BOILERS ON BOARD PASSENGER STEAMERS.—The working of the "Haythorn" boilers on board the Clyde passenger Meg Merrilees—the first passenger vessel plying for hire in home waters under certificate of the Board of Trade to be fitted with water-tube boilers—has been so thoroughly satisfactory that the Southampton, Isle of Wight, and South of England Royal Mail Steam Packet Company, Limited, is following the lead of the Caledonian Steam Packet Company in adopting this type of water-tube boiler for one of its passenger steamers. On the recommendation of Mr. C. W. Murray, their consulting engineer, the directors of the Isle of Wight Company have decided to so equip their saloon excursion steamer Lorna Doone, and an order has accordingly been placed with the Haythorn Tubulous Boiler Syndicate, Glasgow, to supply three of their patent boilers capable of generating steam for about 1700 indicated horse-power. The contract for the necessary alterations to machinery, space, and repairs to hull and machinery has been secured by Messrs. J. Samuel White, and Co., Limited, of Cowes, Isle of Wight, at whose yard the vessel is now lying. The Haythorn boilers on the Meg Merrilees have been in commission about eight months, and Captain James Williamson, the marine superintendent of the Caledonian Company, reports that they are giving every satisfaction.

HIGH-SPEED DOUBLE FLOORING AND MATCHING MACHINE

MESSRS. J. PICKLES AND SON, HEBDEN BRIDGE, ENGINEERS

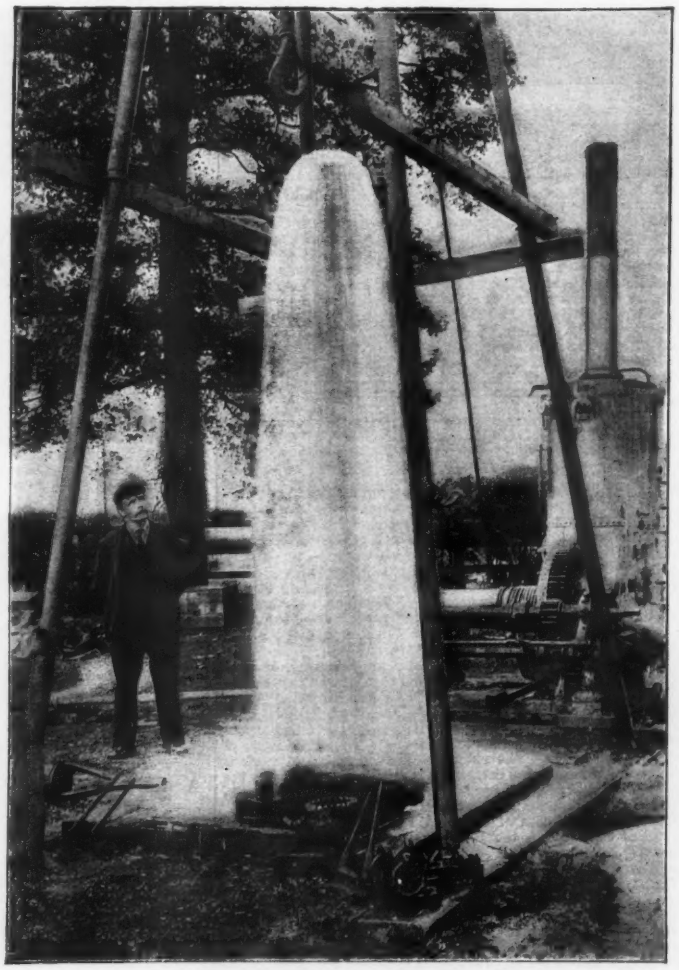


WOOD PLANING MACHINE.

THE illustration herewith represents a new planing machine, patent double or ompound system, specially designed for the rapid production of all kinds of flooring and matching boards. It is constructed to work two boards at a time, thus doubling the output of a single machine. The top and bottom cutter spindles operate on two sides of each board, while the edges are worked by four side-cutter spindles specially arranged to take up the minimum amount of room. The main framework in this machine is made in two sections only, with a planed joint; thus the sides and top are all in one casting, giving a rigidity and stability not otherwise attainable. Each floor board is fed through the machine by eight large calender rollers, all adjustable, and is first operated upon by one bottom cutter spindle, then by stationary irons, over which is an improved pressure arrangement. The tongue and groove are then cut by the side spindles, which are fitted with "Richardson" patent cutter heads; the top side is then planed by a cutter spindle. There are all the necessary side and down pressure arrangements actuated by levers. The countershaft is contained in one solid box-casting, and drives all the necessary spindles from the floor-line, without necessitating any underneath countershafting. The feed motion is worked by cone pulleys and exceedingly strong gearing, with a maximum feed of 120ft. per minute, thus giving a total output of 240ft. per minute.

Other special features in this machine are—that the top and bottom cutter blocks are arranged to give a shearing cut, preventing the driving out of knots, producing better work, and reducing the amount of driving power required. All the spindles are specially lubricated by forced grease lubrication. In the machine as illustrated the floor boards to be worked should each be of about equal thickness, though by the introduction of separate top headstocks and cutter spindles boards of most unequal thickness can be worked together. The value of the machine is also further enhanced by the introduction of a beading spindle at the end of the machine to work each board, also by the introduction of stationary irons for planing every side of the board, thus giving a better quality of finish. The machine is made in two sizes, viz., No. 1, to take in two floor-boards 6in. wide each; and No. 2, to take in two floor-boards 7in. wide each.

This is claimed by the makers, Messrs. J. Pickles and Son, Hebden Bridge, to be the fastest machine extant, especially on account of the double principle introduced, by which means a great saving of room, power, and labour results. There are also many more advantages, especially, perhaps, in the first cost of one compared with two machines for this work.



ARTESIAN WELL AT WERRINGTON

ELECTRICITY SUPPLY IN LANCASHIRE.

Two large electric light and power-supply schemes in the Lancashire district are coming before Parliament this next session. The larger of the two is that of the Lancashire Electric Power Company, which is seeking powers to erect generating stations at four places—namely, St. Helens, Wigan, Little Lever, and Trafford Park, Manchester. As a total the stations when fully equipped are to develope no less than 200,000-horse power, and all are to be interconnected, thus guarding against breakdown, local strike, or colliery accident, &c. They will all, however, be controlled from one centre. The sites of the stations are so chosen that they are all placed adjacent to or have special facilities of access to collieries, so that the cheapest class of fuel can be obtained direct from the pit mouth with the least cost of handling, and in order to avoid stoppage of the electrical supply during a general coal strike, provision is to be made for the accumulation at convenient places of large stocks of fuel purchased when it can be obtained at the lowest prices. Special attention has also been paid to water supply.

The area over which powers are sought is large, extending from Preston to Burnley inclusive on the north, and from Birkenhead to Macclesfield inclusive on the south, thus taking in Liverpool and Manchester, and nearly all the other large towns of Lancashire, and embracing an area of about 1600 square miles. It, moreover, enters into competition with the electrical installations—some of them producing energy at very low cost indeed—of nearly every town in that area. The amount of capital already invested in the district is well over £1,500,000, and in one instance, at all events, special arrangements are already made to supply power at 1½d. per unit. This would no doubt be reduced should a competition come into the field. The engineers to this important scheme are Messrs. Lacey, Clirehugh, and Sillar.

The second company, the South Lancashire and Cheshire Electricity Company, is considerably smaller than the foregoing, and as its one generating station is to be situated at St. Helens, and it intends to supply an area of, roughly, twenty miles round this place, the two schemes obviously overlap one another. The site scheduled by this company for its station is in the midst of residential property, and being some distance from either a colliery or a water supply, its task of competing with existing electrical installations will probably be a great deal more severe than that of the Lancashire Power Company.

ARTESIAN WELL AT WERRINGTON.

THE Great Northern Railway Company has recently had some boring operations carried out at Werrington, near Peterborough Station, which have resulted in a splendid artesian overflow, rising to no less than 20ft. above the surface, and the flow is 300,000 gallons per diem. This copious yield, which will have an important bearing upon the locomotive supply of the district, has been obtained from a tube well reaching 132ft., bored by Messrs. Le Grand and Sutcliff, hydraulic engineers, of London, and the strata penetrated comprise Oxford clay, cornbrash, great oolite claystone, the upper estuarine beds, and terminating in the Lincolnshire limestone, from which last the supply is derived.

Excepting that all the beds of stone passed through were very hard, no special difficulties were overcome. The boring occupied seven and a-half weeks. The tube is 8½in. in diameter, and extends down to 105ft. An outer protective tube 10in. in diameter has been carried down to the bed of the Oxford clay, a distance of 39ft.

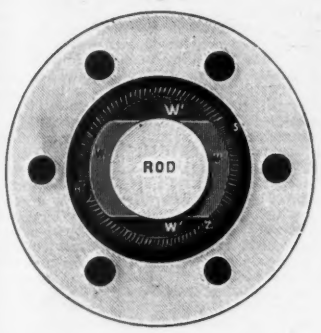
THE LINOTYPE COMPANY'S WORKS.—We have omitted to state that the buildings of the Linotype Company's works at Small Heath, described in our Electrical Supplement, were erected from the designs and under the superintendence of Messrs. Stott and Son, architects, Cross-street, Manchester.

SOCIETY OF ENGINEERS.—The forty-fifth annual general meeting of the Society of Engineers was held on December 12th, at the Rooms of the Society, 17, Victoria-street, Westminster, S.W. The chair was occupied by Mr. William Worby Beaumont, President. It was announced that owing to the increase in his private practice, Mr. Pryce Cuxson, F.S.I., had been compelled to resign his position of secretary of the Society, and a very flattering tribute was paid to him for the services which he had rendered to the Society. It was also announced that Mr. Perry F. Nursey had been appointed to fill the vacancy, and will take office on the 1st of January next.

THE "LANCASTER" METALLIC PISTON PACKING.

SEVERAL improvements in their metallic packing for pistons, of which we give illustrations, have recently been introduced by Messrs. Lancaster and Tonge, Limited, of Pendleton, Manchester. This packing, of which Figs. 1 and 2 are sectional views along and across the rod respectively, consists of two hollow segmental rings of gun-metal which are filled with anti-friction metal, and are pressed to the rod by circumferential springs. The shape of the segments in each ring is clearly shown in Fig. 2, the parts W being pressed to the rod, while the parts W^1 do not touch the rod, but keep the flat joints on each side of the blocks W steam-tight. The chief feature of the packing is the spring Z, which is shown separately in Fig. 3. This is made in two halves, and of square steel wire, the coils of one-half being screwed into the spaces of the other at S, just as in a square-threaded screw and nut. By this means the spring can be shortened by merely screwing the two halves into each other

Fig. 1



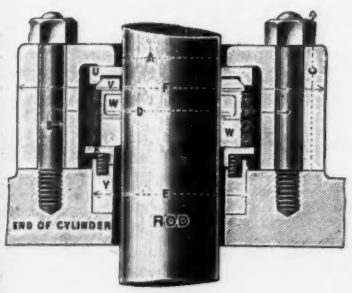


Fig. 2

Fig. 3

to a greater extent, thus making it tighter when put on the outside of the blocks—Fig. 2—the two ends of the spring being then hooked together as at H. By the above arrangement compensation for wear is obtained without any additional complication, and the number of parts in the packing is reduced to the minimum. The spring, as will be seen, is close-lapped except where the halves screw into each other, which largely increases its elasticity as compared with an open spring of similar length, and the washer X, against which the end springs press, in order to keep the transverse joints tight, is

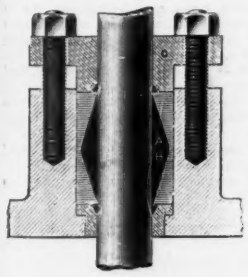


Fig. 4

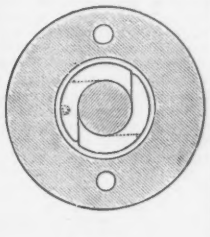


Fig. 5

provided with an internal rim to prevent the springs accidentally coming into contact with the rod, and marking it. Figs. 4 and 5 show the "Lancaster" packing adapted to smaller rods, and to rods working in liquids. The blocks A and B are cut like those in the ordinary packing, as shown in cross section—Fig. 5—but are made conical on the outside, the space behind them being filled with soft metallic packing. By tightening the gland C, as for ordinary packing, the metallic blocks are thus pressed to the rod, and as the flat joints between the blocks are made quite true they remain perfectly steam-tight, as they close on the rod to compensate for wear. For air pumps the space behind the blocks is filled with rubber, which is found to prevent the slightest air leakage, whilst at the same time pressing the blocks very evenly to the rod.

TENDERS.

CITY OF NORWICH.

FOR the widening of Fye Bridge (iron) in the City of Norwich, the following tenders were received :—

	£	s.	d.
Mr. T. H. Blyth, of Foulsham, Norfolk	982	11	6
Messrs. Downing, of Norwick	1180	0	0
Messrs. Cooke and Co., of Westminster	1235	0	0

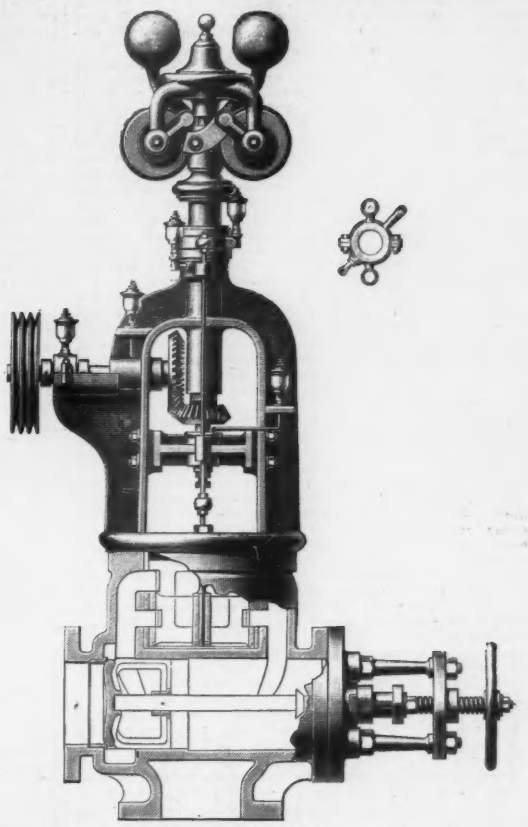
The tender of Mr. Blyth has been recommended for acceptance. The city engineer's estimate for this work was £1000.

For the carrying out of private street works in Mousehold-street, Calvalry-street, Anchor-street, Woodhouse-street, and Stracey-road, Norwich, the following tenders were received :—

	£	s.	d.
Mr. H. Woodham, Blackheath Hill, London (accepted)	1471	18	0
Mr. G. Rackham, of Norwich	1669	15	11
Mr. Clarke, of Norwich	1795	0	0
Mr. Read, of Norwich	1806	0	0
Mr. Glenny, of Colchester	2366	4	10

A SPECIAL GOVERNOR FOR LARGE ENGINES.

THE ordinary type of combined governor and valve, although efficient enough when applied to the general run of engines, is frequently anything but satisfactory when applied to the larger sizes or for exceptionally heavy work. Under the latter conditions some of the parts are subjected to considerable wear, chiefly owing to the want of efficient lubrication, with the result that trouble and expense are involved in repairs or the replacing of worn parts, owing to the difficulty of handling the great weights of the governor. With the object of overcoming the disadvantages incident to the application of the ordinary type of combined governor and valve to a larger class of engines, Messrs. Schäffer and Budenberg, of Manchester, London, and Glasgow, have recently designed and patented a special type of governor, of which we give an illustration in section, showing its general arrangement. In this apparatus all the chief parts subject to wear can be maintained in a state of perfect lubrication, an adequate number of lubricators with adjustable sight-feed being provided for this purpose, and, wherever possible, there are also simple adjustments for taking up all wear. Another feature is that the apparatus is so constructed that the wearing parts are easily accessible, with the object of allowing the replacing of any worn parts without disturbing the governor head or other heavy portions of the apparatus which is so frequently in the heavy type of governors a protracted and serious operation when any repairs become necessary. As will be seen from our illustration, a strong bridge bolted to the frame is provided for carrying the heavy rotating masses of the governor. The main revolving spindle, which supports the governor head, and upon which is fixed the horizontal bevel wheel, is carried in a step bearing arranged in this bridge. The wear in the step bearing can be taken up by a simple set-screw adjsutment to allow of restoring the perfect engagement of the wheels in case of wear. The horizontal bevel wheel is under-driven, thereby preventing this wheel from pressing upon the vertical bevel wheel in consequence of wear in the step bearing. The end of the driving shaft is mounted in an adjustable bearing, and adjustable collars are fitted on each side of this bearing for the purpose of regulating the engagement of the vertical bevel wheel at the end of the shaft. Both bevel wheels can thus be maintained in perfect gear. The throttle valve is supported from the governor sleeve by means of two rods, each guided top and bottom. These rods are connected with corresponding cross pieces, the length of rods between the cross pieces being adjustable to allow of altering the position of the valve if required. The governor sleeve itself is fitted with a bush in halves, and a bush when worn out can be readily renewed at a very small cost. It may be added that Messrs. Schäffer and Budenberg have designed these governors exclusively for the heavier classes of engines, and that they are only suitable for steam pipes of from 7in. diameter upwards.



GOVERNOR FOR LARGE ENGINES

MRS. JOHN HOPKINSON AND CAMBRIDGE UNIVERSITY.

THE following is a copy of the letter written by the Public Orator, Dr. Sandys, thanking Mrs. John Hopkinson, and her son and daughter, for their munificent benefaction to the University of Cambridge. The letter was approved by the Senate on November 10th, and has since been engrossed on parchment, and presented to Mrs. Hopkinson :—

From the Senate of the University of Cambridge to Mrs. John Hopkinson, Mr. Bertram Hopkinson, and Miss Ellen Hopkinson.

The Senate of the University of Cambridge has recently been informed of an offer on the part of Mrs. John Hopkinson, and her son Bertram and her daughter Ellen, to apply the sum of £5000 to the building of a Memorial of her late husband and of her son John Gustave, in connection with the Cambridge School of Engineering. This most generous offer having been gratefully accepted by the Senate, it is now the duty of the University to convey to the donors the most cordial thanks for their munificent benefaction. No gift could be more noble in itself, none more pathetic in its origin, none more appropriate in its purpose.

A sense of gratitude for the gift is blended with a feeling of sympathy and sorrow for the sudden and untimely death of those in whose memory it is offered. By the death of John Hopkinson in the fulness of his bodily and intellectual powers the University has lost one of her most distinguished sons, who, after winning the highest honours in the study of mathematics, attained eminence as an engineer by the integrity of his character and the soundness of his judgment, by the practical sagacity which he felicitously combined with profound knowledge and genius, and by the brilliancy and originality of the work which he accomplished in the cause of science. The University also laments the death of one in the prime of youth, who had looked forward to entering the School of Engineering in the present term, with the hope of following in his father's footsteps.

The memory of the father and the son will be enshrined in the most fitting of memorials, and will be permanently associated with the expansion of the scientific study of engineering in Cambridge ; while the names of the benefactors to whose generosity the Memorial is due, will ever be retained in the grateful remembrance of the University.

Sealed with the Common Seal of the University,
this 10th day of November, A.D. 1898.

THE MORBID ANATOMY OF IRON AND STEEL SHIPS.*

By Mr. S. J. P. THEARLE, Principal Surveyor to Lloyd's Register of Shipping, at Newcastle-on-Tyne.

(*Concluded from page 564.*)

ONE of my most interesting and instructive experiences as a surveyor of ships has recently been described by me in a magazine article. Perhaps some of you have seen the paper to which I refer, and if so, I must beg you to excuse my re-stating the matter now for the benefit of those who have not. A coasting steamer, with a fore peak tank, a cellular double bottom, a long cargo hold, and with engines and boilers right aft, was built under my survey some years ago. She differed from many other steamers which had been built under my survey at the same yard only in being of steel while they were of iron, and in being of fuller form at the bow, of greater speed, and somewhat larger in size. The cellular double bottom was of the type having floors at alternate frames, the intermediate frames being of angle bars only. Now this steamer traded between Glasgow and Dublin, and carried coals from the Clyde, returning light. In the latter condition she trimmed deeply by the stern, even when the fore peak tank was filled with water. When only about a year old I saw her raised upon a slipway, and the appearance of the bow plating at the bottom of the vessel, to a distance of some 12ft. or so abaft the collision bulkhead, was such that I came to the conclusion she had been ashore. I told the captain so, and asked to see his log book. He denied that the vessel had grounded, and his log book had no entry of stranding having occurred. The shell plating at the bow was badly corroded and pitted. A great many of the frame rivets were started, loose and leaking. The cement on the inside was broken. The plating between consecutive floors was set up, and the lower edges of the outer strakes of plating were worn and wasted. Every indication pointed to stranding on a sandy beach, and indeed to several strandings. The wasted and pitted plates were taken off and renewed, and the vessel repaired. A year afterwards I saw her again on the same slipway, and she presented the same appearance as she did the year before. But in the interval, other similarly designed steamers, of a type then just getting into vogue for the coasting trade, had been found presenting similar peculiar appearances. The phenomenon was a new one, simply because the conditions were of recent creation. An evolutionary development of coasting steamers had reached a stage in which new structural conditions had arisen, and what we saw showed some of the conditions to be faulty.

But which were they? And where was the remedy? It took us two years of continual experiment to find out all about it, including the way to put an end to it.

And, now please try to follow me as I endeavour to show you what we gradually discovered in studying case after case that came under our notice. Bear in mind that the vessels trimmed deeply by the stern, and further note that we discovered a personal factor in the first case I came across. It transpired that the captain was a driving man, and noted for his quick passages ; that he ran the vessel as hard as he could whether loaded or light. Further, we found that in all cases the higher powered vessels showed the objectionable symptoms much more readily and markedly than those which steamed slowly ; that steel vessels were the chief sinners, and those of iron were not nearly so liable to the trouble ; that vessels with sharp bows did not suffer at all, nor did vessels that trimmed on nearly an even keel ; that vessels with large fore peak tanks suffered worse than those with smaller ones, and that the bow plating of vessels with floors at every frame was not set up at all, while the plating of those with double-bottom deep floors at alternate frames was always in a started and bulged condition. Well, after a lot of experimenting and thinking, we discovered—First, that by using steel instead of iron the plating was thinner than it would otherwise have been, and that when the lower strakes of bow plating were made $\frac{1}{16}$ to $\frac{2}{16}$ thicker the frame rivets ceased to be wasted at their points because we were now able to give them a deeper and larger countersink. Secondly, by fitting frames of bulb angle section, instead of small plain angles, intermediate between the solid floors throughout that length of the fore part of double bottom which was affected, we stopped the tendency of the plating to be set inwards, which had before been conspicuous. Thirdly, by fitting the laps of the shell plating at the lower part of the vessel, boat-fashion, with the upper edge of each strake on the outside of the strake above, the wasting of the edges was stopped, for no longer were air bubbles collected and imprisoned against the landings every time the bow rose and sank below the surface of the sea.

All that now remains in the vessels so treated of the evil that was a few years ago so conspicuous and destructive, is a greater tendency of the plating to rust at the part in question than elsewhere in the bottom of the vessel. But so long as these vessels trim so deeply by the stern when light, for so long will the lower portion of the bow plating be subjected to influences which must result in speedy rusting. The frequent lifting of that part of the bottom above the sea, and then falling with a thump upon it, must necessarily have such an effect. It is sufficient, however, that the evil is now reduced to within such small limits.

This leads me to consider the general question of wasting by corrosion in iron and steel vessels. And here let me remark that we are about to consider a morbid appearance due to material decay rather than to structural weakness. When vessels were first built of iron it was feared that they would deteriorate most

* A lecture delivered to the Glasgow University Engineering Society.

rapidly on the outer surface in contact with the sea. The rusting of iron under water was a familiar experience, and hence the expectation was a reasonable one. It happens, however, that partly because of the excellent paints and compositions which have been applied to the bottoms of iron and steel vessels, and partly to causes which we are now about to consider, the greatest wasting by corrosion is found to occur on the inside, and not on the outside. The only exception to this general statement is to be found at the water-line, or, as it is termed, "between wind and water." This exception is most marked at the bows of the coasting steamers to which I have just been referring. It is here necessary to remark that in perfectly pure water iron does not rust at all. On the great lakes of North America, where the water is fresh and very pure, it is a usual thing for iron and steel steamers to run for seven or eight years without docking, and therefore without their bottoms being re-coated with paint, and yet these vessels show no indication of material wasting below water. I believe the same results are to a large extent experienced with the steamers running upon Loch Lomond and Loch Katrine. Corrosion in iron and steel ships is, in fact, chiefly due to the action of oxygen, chlorine, and carbonic acid gases, and to such acids as acetic, sulphuric, and hydrochloric, which are formed within the vessel and diluted in the bilge water. On the outside of the vessel above water, and on her iron and steel decks, she is continually being washed with salt water spray which is filled with air bubbles, and so the surface of the metal is continually being exposed to the action of a most destructive mixture. It is just above the water-line that the shell plating suffers most from corrosion, and it is there that the skin tends to become reduced in thickness the most rapidly. Below the surface of the sea, where the side is rarely or never exposed to the atmospheric air, the corrosive action is much less, and may be easily averted altogether by frequent docking and painting, whereas "between wind and water" the paint is quickly removed, and the conditions for rapid wasting readily set up.

But, as I have already said, it is on the inside of the vessel that the greatest mischief is done. Moisture in the cargo—and there is always more or less of it—is evaporated, and rises to the under side of the stringers and deck flats, where it is quickly condensed, and it then trickles down the inside of the shell plating and upon the frames. This is one great cause of the wasting of iron and steel vessels. Another, and often a greater one, is found in the nature of the cargo. Raw sugar is, perhaps, the most destructive cargo an iron or steel ship ever has to carry. The drainage in the form of molasses gets down into the bilge water, where it ferments and becomes alcohol, rapidly undergoing another chemical change into acetic acid. I have known two iron vessels in which the cement on the inside of the bottom was imperfectly laid, leave Natal with cargoes of sugar, and arrive in the Thames in almost a sinking condition, the shell plating being dissolved at some places through the entire thickness by the diluted acetic acid formed in the way I have described. I have known scores of cases in which the cement has saved the shell plating, but in which the floors and framing above the cement level have been dissolved in the same way. The remedy is a complete coating of Portland cement over every part of the vessel that the acetic acid may reach, and a careful washing with lime after every voyage, whereby the alkali neutralises the acid.

Coals are also a destructive cargo, especially when they contain much sulphur in the form of pyrites, and are shipped damp. Hence ironwork in bunkers is more rapidly wasted than in cargo holds. Dry coals may be carried with comparative impunity for a long time, but damp coals, or coals adjacent to an otherwise damp surface of iron or steel, are most destructive. I have known the frames and reverse frames in the bunker of a steel steamer so badly wasted in four years as to require renewal, but in that case water got into the bunker by badly-fitted lids to the deck scuttles. You will easily believe that salt, too, is very injurious to iron and steel vessels, whether carried as a cargo in bulk or as it occurs with salt fish.

Decomposing grain, fruit, or other organic substances lying in the timbers generate acids of a destructive character. In fact, there are very few descriptions of cargo—and certainly neither human beings nor cattle are among the number—which do not contribute to destroy the material of the structure by corrosion on the inside.

I remember the case of a steamer which had for years been bringing copper ore, in the form of copper sulphide, from Huelva to this country, and in which the ceiling was allowed to get worn through in places. One day she came into the Thames leaking badly. After the cargo was discharged I waited at the side of a dry dock until it was pumped out, and then went below her bottom to see where the water had got in. I found water pouring out through some small holes, and with the aid of a hammer I knocked through a great many more, so thin was the plating in places. Upon lifting the worn and broken ceiling on the inside, a strange scene was presented. Lumps of copper ore had got through holes in the ceiling, and with the rolling of the vessel had cut channels through the cement, until the iron shell plating was bared. Then, in the presence of the bilge water, a chemical transference had gone on. The sulphur had left the copper and attacked the iron, for which it had a greater preference. The sulphide of iron so formed had washed up with the roll of the bilge water, and a new surface of iron was exposed to the lumps of copper ore. And so this had gone on until the iron plating was wasted through its entire thickness in places, and much reduced at many others. But, what was queerest of all, the copper ore was left in the form of spongy lumps of almost pure metallic copper. No great ingenuity was required to prevent such a thing as that from recurring. The obvious plan was to make the ceiling thick enough and strong enough and tight enough to prevent the cargo from falling through, and then to keep it in good repair.

Some troubles experienced in steamers are not, however, so easily and simply dealt with, and one of these is plaguing shipowners badly to-day. Double-bottom construction, as you are aware, is now become so general, that very few vessels indeed are built without it. The cellular system of construction is very strong. It affords a good base of support for cargoes, and the presence of an inner bottom is a source of safety, in the event of the outer bottom being penetrated. But one is ever finding a fly in one's pot of ointment. It seems that the advantage of a double bottom cannot well be obtained without incurring a liability to some very expensive disadvantages. The trouble I allude to is found under the boilers, and is due to the heat radiating from them acting upon the surfaces of iron or steel which are kept in a damp condition. If the compartments of double bottom under the boilers were kept dry, the heat from the boilers would have little or no injurious effect upon the plating, framing, &c. And if the compartments, although wet, were kept as cool as those in the other parts of the vessel, it is evident that under like conditions like results would follow, or, in other words, there would not be a rapid rate of wasting experienced. As matters at present stand, it is no unusual thing to find the tank top plating and the floors under the boilers entirely wasted away in the course of eight or nine years, and the rapidity of corrosion is much greater with mild steel than with iron.

Perhaps it will be as well here to consider briefly the phenomenon of the relative rapidity with which mild steel is found to rust, as compared with ordinary commercial wrought iron. Why this should be so is for chemists to explain, but you are all quite familiar with the fact that cast iron rusts very slowly indeed. Before the introduction of mild steel into shipbuilding, it was a matter of common experience that the purer kinds of wrought iron, such as Bowling, Farnley, and Lowmoor, rusted much more readily than did ordinary commercial qualities. It seems that the more nearly the material approximates to pure iron, the more readily it rusts; and hence mild steel, which is the purest form of iron we have to use in shipbuilding, has this sad disadvantage of rapid wasting by corrosion.

In dealing with the double bottom difficulty several remedies have been proposed. These are—(1) Substituting iron for steel in the portion of the framing of vessel under the boilers, making it, of course, of greater thickness than steel scantlings to obtain equivalent strength. This reduces the rate of wasting, but the latter is still too considerable to be neglected.

(2) Covering the tank top under the boilers with a thick layer of Portland cement, having bricks, tiles, &c., embedded in it. This serves to some extent as a non-conductor of heat, and its value is sometimes enhanced by fitting baffle boards under the boilers to still further keep the cement cool. This remedy has not been wholly successful, although it has reduced the evil being combatted.

(3) Omiting the double bottom and the cellular construction of framing under the boilers and substituting for it the old-fashioned arrangement of ordinary floors, keelsons, &c.

This remedy brings matters back to what they were in the days prior to the introduction of double bottoms. The corrosion is still greater than in the other holds, but the life of the boiler itself is generally shorter in duration than that of the framing beneath it, and hence at renewal of boilers there is an opportunity of cheap repair of frames and keelsons. The disadvantages of this remedy are: (*a*) The absence of that element of safety which an inner bottom affords, and that, too, in one of the most considerable and important spaces into which the vessel is subdivided by bulkheads. (*b*) Breaks in the continuity of structural strength at the ends of the boiler compartments, which must be as efficiently supplied as possible by overlapping of keelsons and girders.

(4) By adopting the cellular system of framing under the boilers but omitting alternate strakes of tank top plating, the continuity of longitudinal strength being maintained by thickening the strakes retained and of transverse strength by means of occasional belts of plating under the boiler stools.

This prevents heated moisture from being confined in air-tight spaces to work the mischief experienced in ballast tanks under boilers and has the advantage of no loss of continuity in structural strength. But, again, there is sacrificed in a large and important compartment of the vessel that very valuable source of safety which an inner bottom provides.

(5) Perhaps the best remedy of all is that of keeping the interior of double bottoms below the boilers dry by inducing a rapid circulation of air through them. Pipes lead from the tank top to the funnel uptake, and these convey away air admitted in the ordinary air pipes from the deck. By keeping the surfaces well coated with black enamel varnish and providing such a drying system as I have described, it seems that the evil is at last being completely combatted without any sacrifice either in structural strength or in that element of safety which a double bottom provides. With all our efforts it is to be feared, however, that the boiler compartments and the bunkers will always be more liable to wasting by corrosion than the remainder of the interior of the hull. Indeed, throughout the cargo holds, if care be taken to keep the surfaces clean and well coated with paint, the rate of wasting, especially in iron ships, is very slow indeed. I have recently examined iron steamers of nineteen years of age, in which outside the double bottom the cargo holds showed no signs of wasting at all.

Accessibility to every part of the vessel and closely united parts are two essential conditions for the attainment of this desirable state of things. In old vessels, built at a time when rivets were not spaced so closely in frames, reverse frames, &c., as they are to-day, a very serious source of wasting is to be found through moisture and dirt getting between surfaces not intimately in contact. When rusting is set up at such places its effect upon the strength of the structure is most disastrous. Reverse frames are forced away from frames, beam knees from frames, and frame angles from the shell plating, by the irresistible pressure of the iron oxide formed between them. It is no unusual thing to find that rivets have been broken under the ennormous strain thus set up. Closely-united joints are therefore of importance if only upon this account alone, and how much more important they are upon other grounds I need not point out to you.

The use of mild steel in ship construction, with the possibilities arising from the great ductility of that material, has led to some valuable departures in recent years, tending to minimise the area of surfaces in contact, and at the same time add to the strength of the structure. The joggling of lapped joints is one of these, for by this arrangement we are enabled to dispense with numerous filling pieces or "slips," which have no value except as fillings, and therefore add to the weight of the hull without affording a corresponding amount of strength. Moreover, these fillings uselessly multiply the surfaces in contact, and therefore the tendencies to corrosion between them when not properly united. At first joggled lap joints were used only for deck plating, inner bottom plating, and bulkheads, but now it is not unusual to apply the system to shell plating also.

One very serious source of wasting by corrosion has not yet been met by any remedy. I refer to the rusting of steel and iron decks when not sheathed with wood. The constant falling of salt water spray on iron or steel decks is a serious source of loss of material, which takes place, too, at a rapid rate. I fear that no coating will resist the wear and tear incident to the traffic on the upper surfaces of a weather deck, and hence the metal is inevitably exposed to the corroding influence of sea water spray. The upkeep of bare iron and steel decks, especially the latter, will ere long prove a serious tax upon the shipowner's already very meagre profits. Anyone inventing a coating which would prevent the corrosion of iron and steel decks, and fairly well resist the wear of walking, &c., upon them, would supply a long-felt want and become rich to the bargain.

I have, perhaps, sufficiently occupied your time and tried your patience with my somewhat rambling discussion of the morbid conditions discoverable in iron and steel ships. The subject itself is, however, very far indeed from being exhausted, and every day adds to our knowledge regarding it. Just as the hospital and infirmary are valuable aids in the training of your medical fellow-students to be skilful surgeons and physicians, so are our dry docks and repairing slipways the best of practical training schools for naval architects and shipbuilders. It is upon these grounds that I have chosen this subject for your attention this evening, and it is upon these grounds that I would advise you to ever seek to fortify the knowledge to be gathered from books by that best of all knowledge which is the result of careful and intelligent observation.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal market is very firm, but there is still a want of ready tonnage. House coal shippers complain of want of vessels, but prices keep firm. Steel and iron works well employed for rails, billets, and tin-plate bars, and every prospect of continuance for coming year. Exports for week ending December 10th were:—Coal, foreign, 40,038 tons; coastwise, 15,534 tons. Imports for week ending December 13th were:—Pitwood, 4510 loads; iron ore, 7838 tons; pig iron, 1030 tons; one cargo of lathwood; two cargoes of old iron.

Coal: Best steam, 11s. to 11s. 6d.; seconds, 9s. 9d. to 10s.; house coal, best, 13s.; dock screenings, 6s. 6d.; colliery small, 5s. 3d. to 5s. 6d.; smith's coal, 7s. 6d. Pig iron: Scotch warrants, 43s. 8½d.; hematite warrants, 56s., f.o.b. Cumberland. Iron ore: Rubio, 14s. to 14s. 3d. firm; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails, heavy sections, £4 12s. 6d. to £4 15s.; light ditto, £5 5s. to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 10s. 9d. to 11s.; Siemens—coke finish—11s. to 11s. 3d. Pitwood, 18s. 6d. London Exchange Telegram: Copper, £55 6s. 3d.; Straits tin, £81 15s. Freights: Firm, rates advancing to Mediterranean and Bay Ports.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(*From our own Correspondent.*)

A BUOYANT tone characterises the steel trade, and a satisfactory feature is the manner in which some of the leading works are taking up the manufacture of larger classes of engineering material than has hitherto been usual. Some of the heaviest sections of rounds, squares, and angles ever produced hereabouts have been rolled this week at the Bessemer works of Alfred Hickman, Limited, Bilston. The output of Siemens-Martin steel at the Earl of Dudley's Round Oak Works, Brierley Hill, is fully maintained. Agents for Scotch, Welsh, and other steel from outside districts quoted to-day—Thursday—in Birmingham, £5 to £5 5s. for Bessemer blooms and billets, and 5s. per ton more for best Siemens. Local firms quoted £6 5s. to £6 10s. for angles and girders, £7 to £7 5s. for plates, and £7 to £7 2s. 6d. for bars. The activity of all branches of the engineering trades throughout the kingdom is making the local steel trade more busy than for many years past. Good consignments of various descriptions of iron and steel are going to the Cape and Australia, and inquiries foreshadow shipping orders of value from merchants early next year for various markets, including Cuba, the West Indies, and the Philippines.

The near approach of the Christmas holidays is causing finished ironmakers, like the steel and pig iron firms, to be busy in endeavouring to clear off as many orders as possible, since they anticipate continued activity in nearly all departments in the early part of the New Year. The increasing firmness of the common bar market is one of the chief characteristics of the manufactured iron market at date. Of this material an unusually large output has been made this month, and makers were firm to-day in quoting the standard price of £6 10s. It is anticipated that this class of iron will be 5s. a ton dearer next month; some sellers to-day refusing to accept contracts for deliveries into January at less than £6 15s., which last figure has been the standard rate in the north of the county for some time past. The production of puddled bars has been curtailed of late by the increasing difficulty in getting puddlers. A few years back this class of labour used to be plentiful enough; but the advent of steel, and the consequent proportionate diminution of the output of puddled iron, has caused puddling to be a trade less in repute than formerly, and the new hands who learn it are few and far between. Best marked iron by the list houses is well maintained at £8 for bars, with £7 10s. for second grade. Merchant iron is selling fairly at £6 15s. to £7. The tube strip makers have benefited by the early settlement of the tube trade dispute, which it was at one time feared might affect this material severely. It is now quoted £6 to £6 7s. 6d., and fine strip £6 15s. to £7. Sellers of nut and hurdle iron ask £6 5s. to £6 10s., rivet iron £8 10s., and hoop iron £6 15s. to £7 for serviceable qualities, up to £8 for best. Galvanised corrugated sheets are still quoted £11 to £11 10s. f.o.b. Liverpool; whilst singles are £6 17s. 6d. to £7 2s. 6d.; doubles, £7 2s. 6d. to £7 5s.; and lattens, £7 15s. to £8. The sheet iron mills are busier at date than at any time this year. Prices have been gradually stiffening for some weeks past, and in most cases about 2s. 6d. per ton more is being obtained than a month or six weeks ago.

A good deal more pig iron could be utilised if it was forthcoming, but producers do not desire to spoil prices, and no more furnaces are therefore being blown in. Northampton forge is quoted to-day 49s. to 50s.; the other Midland sorts mostly in request being those which fetch about 50s. to 52s. For Staffordshire makes, cinder pig is quoted 45s. to 45s; part-mine, 48s. to 50s.; ordinary all-mine, 46s. to 57s. 6d.; best ditto, 66s. 6d. to 69s. 6d.; and cold blast, 92s.

The copper market is, as usual, up and down like an india-rubber ball. Good general buying has set in again, and prices are recovering, so that G.M.B. cash is better on the week to the extent of about 6s. 3d. Quotations are about as follows:—G.M.B. cash, £55 10s. to £55 15s.; three months, £55 12s. 6d. to £55 17s. 6d.; tough, £58 5s. to £58 15s.; best selected, £59 5s. to £59 15s.; strong sheets, £36.

Most of the engineering firms in this district are very busy, and some are working overtime. Electrical plant orders are being booked for several months ahead. Boilermakers have taken orders to extend for at least three months, and where steel plates are stipulated there is no little difficulty in getting the material, some of the steel firms stating that they have six months' work on their books. For tanks and colliery air pipes and other plant there is a good demand.

The directors of Hamstead Colliery are considering plans which have been prepared for the re-working of the colliery, which is now closed on account of the recent fire. It is proposed to abandon the portion in which numerous fires have occurred, to fill up the shaft—which was 620 yards deep—for a distance of 40 yards, and to make a road through the "brooch" coal for a distance of about 850 yards, then working down in a slanting direction. By the new plan the company hope to make the mine better than it has ever been, and free from fires.

For their new electrical tramways scheme, the Corporation of Wolverhampton are about to borrow £210,000. Some good contracts for plant and machinery will probably result, from which it is hoped local firms will benefit.

NOTES FROM LANCASHIRE.

(*From our own Correspondents.*)

Manchester.—The considerable drop in warrants during the past fortnight has no doubt in some quarters been taken to confirm the opinion here and there entertained that prices have reached their maximum, and that there is an opening for forward speculation on the basis that probably next year the market may be easier. This, however, by no means represents the prevalent belief, which is rather that the tendency of prices is more likely to be in an upward than in a downward direction. It is pointed out that there is no present or prospective falling off in the large consumption of material that has brought about the strong position in the market, and so long as makers and manufacturers find it difficult to meet the requirements of consumers, there is no probability of any lower prices, whilst the steadily increasing cost of fuel—both coal and coke—is a matter of serious consideration, and must of itself tend to force up correspondingly the price of both iron and steel. The competition of American pig iron, large quantities of which are now arriving, is again talked of as more than likely to have at any rate a regulating effect upon the prices of British iron, but this can only be to a limited extent, and certainly the outlook, as I have previously intimated, points to a continued strong tone, with a more than possible further steady hardening in prices.

The iron market here maintains an exceedingly strong tone, and although business, so far as actually new orders are concerned, has for the present tapered off somewhat, there was quite as much offering at the Manchester 'Change meeting on Tuesday as makers generally were in a position to entertain. For pig iron tolerably large inquiries were here and there reported, but orders just now being booked are generally of no great weight, most of the principal users being fairly well covered for the present, whilst makers, on the other hand, are themselves not in a position to book business of any magnitude except for forward delivery, which they are very cautious about entertaining. Lancashire makers are exceedingly firm at 50s. 6d. for forge to 53s. 6d. for foundry, less 2½ delivered Manchester, and are diffident about selling at all. Lincolnshire makers, although perhaps not holding to the special and, to some extent, prohibitive prices that were recently asked, are still not at all ready sellers at the minimum list basis, and there is no really quotable change

on late rates, forge qualities averaging 47s. 6d. to 48s. 6d., and foundry 51s. 6d. to 52s. 6d., with foundry, Derbyshire, about 53s. to 54s. 6d. net, delivered Manchester. Middlesbrough is perhaps a trifle easier; for good named brands makers still quote 54s. 4d., but ordinary G.M.B.'s could be bought at 52s. 10d. net, by rail Manchester. Scotch iron is also offering at something under the maximum prices asked last week, and there are sellers at about 54s. to 54s. 3d. for Glengarnock, and 54s. 9d. to 55s. 3d. for Eglinton, with American pig iron about 49s. 6d. and 50s. up to 52s. net, delivered Manchester docks.

Finished iron makers are well sold in bars, in some cases over the next two or three months, and prices are exceedingly firm, with makers in most cases not disposed to book new business except at an advance on the official basis rates. Delivered Manchester district, Lancashire bars average £6 10s. to £6 12s. 6d., and North Staffordshire £6 15s. per ton. Sheets are only in moderate request at about £7 5s., and hoop makers could do with more orders than are just now coming forward, but their list rates are steady at £7 for random to £7 5s. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment. In the nut and bolt trade there is an active demand all round, and prices continue to tend upwards, the advance of 10s. per ton on list rates reported last week having been followed by a further upward move, bringing the general advance to about 20s. over the recent minimum quotations.

In the steel trade the position remains much as last reported. Hematites are firm at 65s. 6d. to 66s. 6d., less 2½, local billets remain at £4 15s. net, and steel bars £7 to £7 5s. In steel plates there is a continued hardening, and an increasing difficulty in placing orders for anything like early delivery, some makers being fully booked as far forward as June next, and for boilermaking qualities £8 5s. is now the minimum, with common steel plates scarcely obtainable under £7 15s. delivered Manchester district.

Practically there is nothing really new that I can report with regard to the position generally throughout the engineering trades of this district. All that can be said is that activity is fully maintained in all the leading branches throughout Lancashire, and generally new work continues to come forward in more than sufficient quantity to replace orders running out. The briskness in trade is reflected in the usual monthly returns issued by the workmen's unions. The Steam Engine Makers' Society has only 1 per cent. of its total membership on donation, whilst in Manchester, Oldham, and Bolton, this organisation has practically no members on the list, and in the last-named district one or two of the principal firms are, I understand, going on night shifts. The returns of the United Machine Workers' Association also show a reduction in the number of unemployed, which now represent 2⅜ per cent. of the total membership; whilst in Manchester this society has not more than 1½ per cent. on benefit, and in Wigan, Preston, Crewe, Lancaster, Ashton, Barrow, and Horwich, there are practically no members receiving donation. Returns as to the state of trade continue very satisfactory, only one branch reporting it as "bad."

Some time back I referred briefly in my Lancashire notes to an ingenious but very simple arrangement for practically suspending incandescent gas burners upon a resilient spring coil, formed out of a thin metal tube conveying the gas to the burner, which completely protected the fragile mantle from destruction by vibration under such exceptional conditions that it was possible to employ an incandescent light in the steam-hammer shop of a foundry. Mr. W. R. Clay, of Messrs. Clay and Walmsley, Bolton, the patentee of this device, has since introduced further improvements. His first arrangement, although very effective for the purpose, possessed under certain conditions a defect in the very fact of its extreme sensitiveness to the least vibratory wave, with the result that, owing to the lightness of the fitting and the consequent lack of inertia, when the fitting was once agitated the state of motion was kept up for a considerable time. To remove this defect Mr. Clay has introduced a new method of ballasting the fitting by the attachment of a heavy body to the base of the burner; but a further and more important improvement is what he has termed a "floating Bunsen" anti-vibrator, in which no pipe of any kind need be used—that is to say, as part of the apparatus. This consists simply of a wire frame, at the bottom of which a cone is attached, whilst the frame is provided with suitable sensitive springs to give the resilient effect. In order to adapt this anti-vibrator to an incandescent burner, the nipple of the burner is screwed on to the existing gas pipe in the lantern, whilst the Bunsen from which it is taken is screwed on to the cone. The result of this arrangement is to increase considerably the efficiency of the Bunsen flame, owing partly to the fact that the cone induces an enlarged volume of air into the Bunsen tube, thus effecting an improvement in the incandescence of the mantle. If, however, there is any objection to the above method of suspension, the burner may be supported in a different way, the Bunsen tube being fitted with springs upon which a heavy body rests, carrying the heavier portion of the burner.

At a meeting of the Northern Society of Electrical Engineers, held in Manchester last week, Mr. Paul Schon, in the course of a paper on "Superheated Steam and its Application to Steam Engines," after describing the Schmidt types of steam engine and superheater, expressed the opinion that there was a great future for the use of superheated steam, especially for steam engines driving large electricity supply stations, as the heavy losses that at present took place, on account of the steam having during certain periods of the day to work with only half loads, could be prevented by adopting the Schmidt system. In Manchester there would shortly be laid down two boilers, each connected with a Schmidt superheater, and each plant capable of producing 10,000 lb. of steam per hour. The boilers would be heated by Mond's producer gas, and the steam would drive a 1000-horse power Raworth engine, to be used for electric traction.

An active demand is reported for all descriptions of fuel, with a very strong tone as regards prices, and a more or less general advance on round coals, with possibly a further advance on engine fuel, is talked of by the leading Lancashire colliery representatives as not at all improbable with the close of the present month. The better qualities of round coal, although not in actually pressing request, are moving away freely, and prices are exceedingly firm at the full rates. Common round coals continue in brisk inland demand for steam forge and other manufacturing requirements, with a hardening tendency, although there is no quotable change upon late prices, 7s. 9d. up to 8s. 3d. remaining about the average figures for good ordinary qualities of steam and forge coal at the pit mouth. The recent advance in engine fuel has in no way checked the demand for all descriptions of slack; in fact, collieries report more inquiries coming forward than they can entertain, and in most cases offers of new business have to be declined. The result is, that not only is the recent advance readily obtainable, but where collieries are in a position to book new business they are asking further special advances, and at the pit mouth common slack could scarcely now be bought under 4s. to 4s. 3d.; good medium sorts, 4s. 9d. to 5s.; with best slacks quoted about 5s. 6d. per ton.

For shipment, inquiry is fairly active, and prices are strong at recent quotations, 9s. to 9s. 6d. being got readily for ordinary steam coal, delivered Mersey ports.

The correlation of British and European carboniferous beds was brought forward for discussion by the members of the Manchester Geological Society at their meeting on Tuesday, in a short paper read by Dr. Wheelton Hind, who based his remarks chiefly on stratigraphical and palæontological observations. In the course of the discussion, Mr. Holroyd said that on broad lines a binary division of the British carboniferous system would seem to meet all the requirements. It would certainly seem that the system could best be explained on the basis of palæontological facts. Mr. Joseph Dickinson remarked that Dr. Hind based his theory on palæontological rather that lithological grounds. If, however, they discarded the "Yoredale" series, an immense body of rocks would be left without a name. He did not feel disposed to give up entirely the lithological divisions of the carboniferous series, and be guided solely by palæontological considerations, which formed a good guide, but not the only one. Mr. Mark Stirrup observed that the palæontological facts were the only safe guide on this question, and Mr. Law said it had been thought for a long time that there was a great resemblance between the fossils of the carboniferous limestone and those of the Yoredales and the millstone grit.

Barrow.—There is a good demand for hematite pig iron, but the market at present is largely in the hands of the "bears," who have depressed prices to prevent a squeeze in warrants, and in order to do this they have run into stock no less than 33,565 tons of pig iron during the week, bringing stocks up to 171,728 tons, or 12,722 tons less than at the beginning of the year. In the meantime it is remarkable that makers are so very fully sold forward that they have practically no iron to sell, and they have only forty furnaces in blast, as compared with forty-one in the corresponding week of last year. Prices are very steady for makers' iron at 57s. to 58s. per ton, nominal, net f.o.b., while warrant iron is down at 56s. 1d. net cash sellers, 56s. buyers.

There is a very brisk demand for iron ore of all qualities, even poor samples finding a very good market. Prices are steady at 11s. for common, 14s. for good average, and 17s. 6d. for best Hodbarrow net at mines. Raisers are not selling in big parcels, as it is evident there will be an improvement in price if an export tariff, as threatened, is put on Spanish ores shipped to this country.

The steel trade is very busy in every department, and orders are very fully held by makers. Heavy steel rails are in brisk request on home and colonial account, and prices are firm at £4 12s. 6d. per ton net f.o.b., while light sections are also in good demand at £5 12s. 6d.

Shipbuilding descriptions of steel are in very good demand; indeed, makers are being rushed to get out orders they now hold, and are being pressed to accept new work. The custom coming to Barrow at present for shipbuilding material embraces not only orders from Belfast and Glasgow, but from Liverpool, the dockyards, and builders on the East Coast. There is a growing business in heavy plates, light plates, heavy steel castings, sections, &c., and the works at Barrow are being extended in consequence. Heavy ship plates are quoted this week at £6 17s. per ton.

The coal and coke trades are very fully employed, and good prices are ruling. Coke practically costs 21s. per ton net at West Coast furnaces. It is in good demand, and in very regular supply.

The shipping trade at West Coast ports is very well employed. During last week 4900 tons of pig iron and 7560 tons of steel were exported from West Coast ports, as compared with 4197 tons of pig iron and 5248 tons of steel in the corresponding week of last year, showing an increase of 703 tons of pig iron and 2312 tons of steel. The aggregate shipments this year to date total up to 496,472 tons of pig iron and 494,085 tons of steel, as compared with 416,179 tons of pig iron and 443,044 tons of steel in the corresponding period of last year, showing an increase of 80,293 tons of pig iron and 51,041 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE satisfactory condition of the Yorkshire coal trade previously noted continues to be firmly maintained. The pits are working exceptionally well, and the output is consequently large; but a market is found for all that is brought to bank. Several collieries which are mainly in the steam-coal trade are a little less pressed for deliveries, owing to the export business slowing down. For house coal there has been a fair demand during the week, although the further mild weather has caused less activity. To London the tonnage of secondary qualities of coal is still noted as larger than usual; and metropolitan consumers appear to be waking up to the fact that some of what are considered lower grades of coal are quite good enough for all ordinary household purposes. Values of household fuel keep at the high figures noted last week, best Silkstones fetching from 9s. 6d. to 10s. per ton; ordinary, from 7s. 6d. per ton; Barnsley house, 8s. to 9s. per ton, with about 7s. per ton for seconds. Although we are now in the middle of the last month of the year, the steam-coal trade keeps unusually brisk, the iron manufacturers and the railway companies requiring full supplies, and the Humber ports receiving very freely. There is a good deal of talk at present as to prices for next season's contracts. It is exceedingly probable that the railway companies will have to pay a little more for their new supplies. At present the rate being paid is from 7s. 3d. to 7s. 9d. per ton, while hard coal bought in the open market has not been obtainable at less than from 1s. to 2s. per ton above these figures. Barnsley hards are at present quoted 8s. to 8s. 6d. per ton; seconds from 7s. per ton. A good demand exists for gas coal, and engine fuel of all descriptions finds a ready sale. Nuts, 6s. 6d. to 7s. 6d. per ton; screened slack from 4s. 6d. per ton; pit slack from 3s. per ton. The coke ovens keep in full work, with a strong demand and values still rising. Ordinary coke, 9s. 6d. to 10s. 6d. per ton; best washed coke, 11s. 6d. to 12s. 6d. per ton.

Several further orders for armour plates distributed between the three Sheffield firms have been followed by considerable work in the ordnance department. Some important orders have been placed for heavy gun forgings required for the battleships now being constructed by the British Admiralty. It is stated, however, that while armour plates and gun forgings are being very largely produced, her Majesty's Government are not taking advantage of the plant specially put down for armour-piercing projectiles. This plant is of a very costly nature, and the highly skilled workmen required upon it having to be well paid, a considerable loss is thus entailed through the plant being unemployed. One reason given for the delay is that the authorities are stated to be undecided about continuing the present design of armour-piercing projectiles, and there is no indication as to when a decision will be come to. Lyddite shells, which did such good work in the Soudan campaign, are expected to be freely ordered, but as yet nothing is known as to when the work may be placed. Our local firms have equipped their establishments so as to accomplish a large output when required, either for military or naval purposes. Every battleship has to be provided with a specific number of projectiles, and it is hoped that a decision will soon be arrived at so as to save manufacturers from the loss and inconvenience caused by the present lack of work. In common cast steel shells there is no lack of employment, one of our local firms being particularly well off in work of this description. All kinds of marine material, particularly in heavy shafting, are in brisk request, and a rise in prices for future deliveries is being obtained.

In the lighter trades of the city there is less doing in season goods this year in the silver-plating establishments, the tendency being towards the production of articles of household use rather than of ornamental wares specially produced for present-giving. Sterling silver goods are in increasing request, the cheapness of silver causing the difference between these wares and "A" electro plate to be so small that customers have preferred to take silver, although, no doubt, in actual domestic use the first-class electro plate would be more durable. In cutlery of the best descriptions the rapid advance in ivory has caused considerable embarrassment to manufacturers who have been unable to obtain such advances in prices as would compensate them for the increased cost of hafting. Difficulty is also experienced in obtaining adequate supplies of best stag horns, which have risen rapidly in value. For carvers stag horns are in great request, particularly for the United States, one of our local firms, by no means amongst the largest, having this week received an order from that market alone for 2000 pairs of carvers.

The death is reported of Alderman Michael Hunter, one of the oldest and best known of Sheffield manufacturers. The deceased was the head of the firm of Messrs. Michael Hunter and Sons, was Master Cutler in 1860, twice Mayor of Sheffield, a member of the Town Trust, and chairman of the Sheffield Guardians for a series of years. The business of the firm was in the manufacture of saws, files, edge tools, spring-knife cutlery, scythes, sickles, &c., carried on at the Talbot Works, Savile-street, Sheffield.

At an extraordinay meeting of the Sheffield City Council, held on the 14th inst., sanction was given to the promotion of a Bill in Parliament to acquire the waters of the Derwent and Ashop for the city, the intention being to let Rotherham and Doncaster participate as well in the proposed addition to Sheffield's resources. The Council further approved the opposition to the Leicester and Derby Water Bills, and also sanctioned the promotion of a Bill for the purchase of the Sheffield markets from the Duke of Norfolk.

NORTH OF ENGLAND.

(From our own Correspondent.)

As is usual at this period of the year the business in pig iron is of comparatively small extent, owing to the holidays, stock-taking, and the small demand on shipping account. To these causes may this year be added the reaction following last month's gamble in Cleveland warrants, which lasted long enough to land the trade in the quietest part of the year, when a rapid recovery could not be looked for. Further than this, the "bears," who suffered so heavily last month, are commencing operations with the view of recouping themselves for some of their losses, and are taking advantage of the lull to depress further the prices of warrants. These have been declining since the termination of the "squeeze," but that was only to be expected, for it was unlikely that the prices of Cleveland warrants, which were chiefly raised above 43s. by the speculation, would be maintained when that speculation ceased. As prices have been sliding down, the "bears" endeavour to accelerate the pace at which they are falling, and they hope to be able to knock off another shilling or two within a short time, as things just now favour them. This action rather unsettles the market for pig iron, and there are very few buying either for prompt or forward delivery.

But it is believed that this tendency in pig iron will be of short duration, and that an upward movement will set in early in the New Year. The business in Cleveland pig iron, or on the warrant market at the present time, can in no sense be accepted as an index of the general condition of the iron and steel industries, as it often is, for it is certain that the iron and steel trades, as a whole, are anything but unsatisfactory. On the contrary, the business is extraordinarily active and prosperous, and there is good reason to believe that it will continue so for months ahead; in fact, manufacturers expect that 1899 will be an even more prosperous period than the present year has been. This being so, it can hardly be believed that with briskness in the manufactured iron and steel industries there can be depression in pig iron, more especially as the stocks of the latter are small, and the production even at this dull time of the year is not in excess of requirements. Blast furnace owners therefore look to the future with confidence, and are in no hurry to sell.

The general price ruling this week for No. 3 Cleveland G.M.B. pig iron for early f.o.b. delivery has been 44s. 6d. per ton. This is, of course, considerably less than was paid in some cases last month, 48s. being paid for shipment, and even up to 51s. where the iron was to go into the public stores, but no one ever expected that the prices would be kept at those inflated figures when trade resumed its ordinary course. The prices, however, have not fallen to the level that ruled when the "gamble" began. No. 3 is 1s. 6d. higher than that, and it is 4s. 6d. above the minimum price of the year, which was reported in July, and 2s. 6d. above the year's average, which average, it may be remarked, is the best that has been reported since 1890. No. 1 is about 46s.; No. 4 foundry, 44s. 3d.; and grey forge, 42s. 3d. The last named is only 9d. below the best price of the year, and is 4s. above the minimum, that being reported in April last. Some makers are getting as much for their No. 4 foundry as they are securing for No. 3, this quality being very scarce, and there has been an extra demand for it on account of the recent dearness of No. 3.

The business in hematite pig iron is satisfactory, and the price of mixed numbers is 54s. 9d. per ton, a figure which consumers can well afford to give, seeing how much the prices of steel have advanced of late, and how prosperous the trade in it promises to be next year. The prices of Rubio ore are hardening, as it is reported that the Spanish Government propose to institute an export duty on ore, in order to assist them in replenishing their exhausted exchequer. It will be remembered that in the spring of this year, when war between Spain and the United States was imminent, they proposed to levy such a duty, but ultimately placed the tax on shipping instead; it, however, fell on the consumer of ore just the same, because the shipowners increased their rates of freight to cover it, and freights have never been so low this year as they were last. About 15s. per ton delivered in this district has now to be paid for average Rubio ore, this being the top price of the year, and 1s. above the minimum. Imports of foreign ore into the Tees have this year been comparatively poor, smaller, in fact, than they have been since 1892; they will not be much above 1,100,000 tons, whereas in 1894 no less than 1,574,037 tons were received. Pig iron workers have used as much ore as in the previous year, but they have been using up their stocks of ore, which were very heavy in the early part of the year.

Shipments of pig iron from the Cleveland district, which were considerably curtailed last month, owing to the gamble in pig iron warrants, are improving this month, and they have reached 37,556 tons, as compared with 39,571 tons in November, and 37,663 tons in December, 1897, to 14th. The stock of Cleveland pig iron in Connal's warrant stores continues to increase, but not now heavily. On Wednesday night 128,792 tons were held, an increase of 5048 tons for the month. This year the stock has increased about 52,000 tons—nearly all during the last three months—whereas in 1897 there was a decrease of over 84,000 tons. The stock of hematite pig iron held in the warrant stores was 34,761 tons, a decrease of 1897 tons this month, and of nearly 17,000 tons this year.

There can be no doubt about the excellent trade done in the manufactured iron and steel industries; never have more encouraging reports been given by all connected therewith, and it is no exaggeration to say that they are well satisfied with the present situation and also with the prospects for next year; indeed, they are pretty certain of as good a trade as they have had this year, if not, indeed, a better one. Everyone is so full of work, and will be for months ahead, that competition among producers has become a thing of the past, and consumers find it very difficult to place orders for anything like early delivery; they are fortunate if they get their contracts executed within three or four months. Nearly all this is due to the excellence of the home business, for undoubtedly the demand from abroad has fallen off, as is apparent by the shipments. The fact is that our prices have risen so much that foreign buyers are now able to purchase at home on more favourable terms. That, however, is not a circumstance which will induce local manufacturers to compete, because it is not likely, if they can get their books full of home contracts at the high prices, they will take several shillings a ton less in order to do business with the foreigner. It will be time enough to do that when they begin to get short of home orders. That time will not come as long as the shipbuilding industry continues prosperous, and it is extraordinarily so at the present time. Common iron bars are realising £6 2s. 6d.; best bars, £6 12s. 6d.; best best bars, £7 12s. 6d.; steel ship plates, £6 15s.; steel boiler plates, £7 5s.; steel girder plates, £7; steel ship angles, £6 10s.; steel engineering angles, £6 15s.; iron ship angles, £6 2s. 6d.; iron ship plates, £6 10s.; packing iron, £5 2s. 6d.; steel sheets (singles), £7 17s. 6d.; heavy steel rails, £4 12s. 6d.; cast iron chairs, £3 5s.;

steel railway sleepers, £5 17s. 6d. per ton, all less 2½ per cent. f.o.t. except rails, chairs, and sleepers, which are net.

The shipbuilding and engineering industries are unprecedentedly active, and as regards output 1898 will be the record year with figures much in excess of any other year. The statistics so far as they have been collected show this clearly. The Wear shipbuilders have launched 262,970 tons of shipping—81,556 tons more than in 1897; all but two of these have been steel screw steamers, the majority being of over 3000 tons gross register. Of the fourteen shipbuilding firms not one has to report a decrease on last year. The Hartlepool builders have launched 119,430 tons, or 55,733 tons more than in 1897, and one of the firms, Sir William Gray and Co., launched 72,723 tons, which, it is claimed, will put them at the head of the builders throughout the world, as they were in 1890. No firm in the world has ever built so large a tonnage in a twelvemonth as have Sir William Gray and Co. this year. They have launched twenty-seven steamers, or one a fortnight on an average. The Middlesbrough yards have launched 52,772 tons, or 12,750 tons increase on 1897. The Stockton returns are not complete, but Messrs. Ropner and Sons have launched 43,647 tons, and Messrs. Craig Taylor and Co., 17,004 tons. At Blyth, 6349 gross tons of shipping have been launched, 1085 tons more than in 1897. Messrs. Blair and Co., Limited, Stockton, have had a record year, as they have engined thirty-five steamers, the total indicated horse-power being 46,000, whereas in 1897 their record was twenty-five steamers and 32,600-indicated horse-power. All were triple-expansion engines.

The coal trade is very active in all branches, and prices are very firm, as coalowners have not a great deal of coal available for sale, though their pits are working up to the fullest capacity. Great pressure for supplies s manifested by consumers, who are making preparations for the holidays. It is not often that the steam coal trade is so brisk in the winter as it is at present, and the prices are more favourable than usual for the sellers, best steam being at 9s. 9d. to 10s. per ton delivered, and small, which is selling more fully than of late, is realising 4s. 9d. per ton. Best gas coals are steady at 9s. 6d. to 10s. per ton f.o.b. Blast furnace proprietors are paying on the average 15s. 6d. per ton for their coke delivered at the furnaces on Teesside. The owners of the Victoria Garesfield and Waldridge Collieries will on 1st proximo take over the pits and brickworks belonging to Messrs. Joseph Cowen and Co., and will carry on business under the style of The Owners of the Priestman Collieries. The Blaydon Brickworks will, however, not be transferred, but will still be carried on by Messrs. Joseph Cowen and Co. The collieries under the control of the company will be:—Victoria Garesfield, Waldridge, Chester South Moor, and Blaydon Burn, and the Lilly at Rowlands Gill.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE pig iron market has been further depressed in consequence of rumours that there has in recent weeks been a much larger increase in stocks in the North of England than had been anticipated. This increase has come as a surprise, the general belief having been that all the available hematite pig iron was going into immediate consumption. There were fears that a large break-away in prices might take place, but it is thought this can only occur if the increase in stocks should continue on an extensive scale. Manufacturers have been complaining that the raw material was becoming too high to admit of profitable working in view of the comparatively moderate prices of finished articles, and if prices of pigs do not go much lower, there will probably not be much harm done to trade generally. Of course, a considerable proportion of recent advances were due to speculation, the influence of which has, for the time, been pretty well spent.

Business has been done in Scotch warrants from 48s. 11d. to 48s. 8½d. cash, and 49s. 1½d. to 49s. one month. The market for ordinary Cleveland warrants still remains comparatively disorganised. A limited quantity of this class of iron changed hands at 44s. 4½d. for cash. Cumberland hematite warrants sold at 56s. 8d. to 56s. 3d. cash, 56s. 1d. for delivery in twenty-one days, and 56s. 11d. to 56s. 4d. one month. The drop of extent in the month's delivery was undoubtedly due to the belief that, in consequence of the reported increase of stocks in West Cumberland, iron is likely to be had at cheaper rates. Middlesbrough hematite is coming into the market more freely than has been the case for a considerable time. Transactions in this iron were recorded in Glasgow market at 54s. 4½d. cash, 54s. 8½d. for delivery in twenty-one days, and 54s. 6d. and 54s. 6½d. one month.

The output of pig iron in Scotland is fully maintained, that of hematite being the greatest on record. At present there are 46 furnaces producing hematite, 32 ordinary, and four basic iron, the total of 82 thus in operation in Scotland comparing with 81 at this time last year.

Prices of Scotch makers' iron are steady, particularly special brands. Govan and Monkland, f.o.b. at Glasgow, Nos. 1, are quoted 50s. 1½d.; Nos. 3, 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 49s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Gartsherrie, No. 1, 56s.; No. 3, 51s.; Calder, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Coltness, No. 1, 58s.; No. 3, 57s. 6d.; Glengarnock, at Ardrossan, No. 1, 55s.; No. 3, 50s.; Eglinton, at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Dalmellington, at Ayr, No. 1, 51s. 6d.; No. 3, 50s.; Shotts at Leith, No. 1, 56s.; No. 3, 51s.; Carron, at Grangemouth, No. 1, 56s.; No. 3, 51s. per ton. The values of G.M.B. have, of course, been following to some extent the course of the warrant market, although the ironmasters report that they have little or no difficulty in disposing of their iron.

The stock of pig iron in Glasgow warrant stores shows a decrease for the past week of 915 tons. The arrival of English pigs at Grangemouth amounted to 9269 tons, being 2063 more than in the corresponding week.

The shipments of pig iron from Scottish ports in the past week amounted to 4173 tons, compared with 5101 in the corresponding week of last year. To Holland 290 tons were despatched, India 200, Germany 220, South America 15, Australia 75, France 100, Italy 140, Russia 158, Belgium 100, Spain and Portugal 242, China and Japan 105, other countries 60; the coastwise shipments being 2468 tons, against 1701 in the same week of 1897.

In the manufacturing branches there is no lack of employment. A fair turnover is taking place in malleable iron bars, sheets, plates, &c., at steady prices. The steel trade is as busy as ever, and there is a prospect of the general activity being maintained for a considerable time.

The coal trade has been suffering much inconvenience from a block of traffic on the railways, which has been more or less acute for weeks, and which the railway companies find it very difficult to overcome. The trouble really began during foggy weather, and it has not been possible so far to work off the arrears satisfactorily, notwithstanding that traffic has been conducted night and day, and even on Sundays. Not only the coal shippers, but the iron and steel makers, have felt the inconvenience of the block. Supplies have run short to such an extent as even to threaten the stoppage of furnaces; the prices have been unnecessarily enhanced, and thus the cost of production increased. The coal shipments from Scottish ports on the past week have amounted to 150,814 tons, compared with 153,514 in the preceding week, and 151,650 in the corresponding week of last year. Prices are firm all round, both for home use and shipment.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

OWING to the lack of ready tonnage, and the high ruling of freights for all the Mediterranean ports, there was a falling off in coal shipments at Cardiff last week. The total from all Cardiff ports did not quite reach 330,000 tons, but this caused little notice, heavy shipments being forthcoming. At the close of the week there were some exceptionally large consignments, 4000 tons going to Leghorn, 5000 tons to Rio, 7500 tons to Aden, 3800 tons to Port Said. This week, again, large cargoes went to Malta, Bombay, Batavia, 6000 tons Jamaica, Brindisi, Genoa, and Rio, 5500 tons to Port Said, and 3500 tons to Cape Town. Coaling stations are receiving close attention. Similar causes to those affecting Cardiff affected more or less the other ports last week, and in addition, with regard to Swansea, a little slackness prevailed at the two pits belonging to the Birchgrove Graigola Company. Newport, Mon., total was only 40,038 tons foreign, and 15,534 tons coastwise.

This week, at Cardiff, outward chartering opened briskly; and rates, especially for the Egyptian and Mediterranean ports, continue firm. In patent fuel a steady, unceasing demand is coming into notice. Genoa has been a large buyer of late, from Cardiff; and large shipments have gone to Vera Cruz and Barcelona. Amongst the prominent cargoes of the week from Swansea have been one of 2900 tons and another of 1000 tons for France.

Prices of coal keep very firm, especially for early loading. Closing figures, Cardiff Exchange, were as follows:—Best steam, 13s. to 13s. 6d.; seconds, 11s. to 12s. 6d.; drys, 10s. 6d. to 10s. 9d.; best Monmouthshire, 10s. 9d. to 11s. 3d.; seconds, 9s. 6d. to 10s. Special steam smalls, 6s. 3d. to 6s. 6d.; best ordinary, 5s. to 5s. 6d.; seconds and inferior, 4s. 3d. to 4s. 6d.; best household, 13s. to 14s.; No. 3 Rhondda, 12s. 6d. to 13s.; brush, 10s. to 11s. 6d.; small, 9s. 6d. to 10s.; No. 2 Rhondda, 8s. 6d. to 9s. 3d.; small, 5s. to 5s. 3d. Swansea prices:—Anthracite, 14s. to 14s. 6d.; seconds, 12s. 6d. to 13s.; ordinary, 11s. to 11s. 6d.; culm, according to position of stem. Steam coal, 11s. to 11s. 3d.; seconds, 9s. 6d. to 10s. 3d.; bunkers, 7s. 9d. to 8s. 3d.; small, 4s. 6d. to 5s. 9d. House coal: No. 3 Rhondda, 12s. to 13s.; No. 2 Rhondda, 9s. to 9s. 6d.; through, 7s. 9d. to 8s.; small, 5s. to 5s. 6d.

The publication of November statistics of the iron and coal shipments has just been made, and no doubt will be read with interest, as showing how the great industries are recovering lost ground. The total coal shipments from Wales during November were 1,884,809 tons, compared with 1,557,299 tons for the corresponding period of 1897. Compared with the month of October this shows an increase of 192,518 tons.

Taking the coal shipments of Cardiff during the year, I find that the highest was in January, when 1,708,892 tons were shipped. The shadow of the coming strike then appears to have fallen, and each month the shipments became smaller, the smallest month of all being October, when the total was only 361,014 tons. Newport, Mon., despatched 342,232 tons in November, against 271,155 tons. The highest shipment from Newport during the year, so far, was 362,432 tons, and the lowest 49,145 tons, May, 1898.

Swansea does not show so marked a contrast. During last month it shipped 203,617 tons. The highest total, excepting this, was in January, when the shipment was 175,935 tons. The lowest shipment was in April, 93,969 tons.

The leading industries show gratifying totals at all ports.

During the year up to the end of November, Cardiff has sent away 28,415 tons of iron and steel, Newport 29,209, and Swansea 6735 tons. In patent fuel, Cardiff has despatched 216,171 tons, Swansea 356,326 tons, and Newport, Mon., 50,200 tons. In coke, Cardiff shipped 45,847 tons, Swansea 13,845, and Newport, Mon., 7090 tons. Newport, Mon., remains still the leading port for iron and steel shipments, Swansea the first in patent fuel, and Cardiff in coal. In the case of patent fuel, Cardiff promises to run Swansea more closely in future.

One of the longest of strikes at Ebbw Vale, that of the boilermakers, has just been brought to an amicable conclusion. It has lasted seventeen months, and was ended by the joint action of Alderman Powell, manager at Ebbw Vale, and Mr. Fox, of Cardiff, who represented the men. The men, it appears, had been affiliated with the Boilermakers' Union, and had been supported by the Union throughout.

The Ebbw Vale management continues to import ore largely, one shipment this week from Castre consisting of 3200 tons.

The seamen's dispute is practically over at Cardiff. On Monday only two vessels signed on during the morning; one a steamer at £4 10s. all round, and the other a sailing ship at £3. At Newport, Mon., a crew signed on for the steamer Irwin at 32s. 6d. upon a weekly agreement. In one case there was a slight difficulty, 30s. being offered; the crew left to a man. In the case of a vessel despatched from Cardiff by a northern firm, only the officers were engaged in Newport; all the crew were engaged abroad.

Amongst the iron ore consignments of the week those from Bilbao figured principally, but one cargo came in from Bordeaux to the Pyle Company. The activity in iron and steel has also led to increased imports of pig iron, some from Spain, but the greater part from Whitehaven and Grimsby.

Undiminished vigour again characterised the leading works, rails, bars, billets, fish-plates, and sleepers being principally in demand. Great activity continues at all the steel-producing establishments of the Swansea Valley. Five furnaces were in at Wright and Butler's, two at Cwmfelin, two at Millbrook, five at the Upper Forest, two at Duffryn, and four at Pontardawe. Tin-bars formed a special item of production. The Worcester Works re start is being well pushed forward. On Saturday the furnaces of four of the mills were lit up, and business was in full drive by mid-week.

At the date of my despatch preparations were on the eve of completion for re-starting the large furnace at Tredegar Works, and this is to be soon followed by the blowing in of a second. This is one of the best indications that has been given of the renewed life of the steel trade. At the early part of the year a small furnace was lit at Tredegar, but the start was ended by the strike.

The Dowlais Works are associated with large furnaces and great outputs, and now the mills are coming into prominence for rails of unusual dimensions. Last week the record was broken by the rolling of one two tons weight, the largest ever made at Dowlais.

On 'Change, Swansea, mid-week, it was reported that the pig iron market had been receding again in the week, showing a further fall of about 6d. all round. Shipments have been a fair average, but stocks show an increase in hematite and Cleveland, but a decrease in Scotch.

Latest prices:—Glasgow warrants, 48s. 10d., 48s. 9½d. cash buyers; Middlesbrough No. 3, 44s. 4½d. prompt, other numbers in proportion. Hematite warrants, 56s. 3½d. for mixed numbers f.o.b. Cumberland, according to brand. Middlesbrough hematite, 54s. 4½d.; Welsh bars, £6 7s. 6d. to £6 10s.; sheet iron and steel, £7 to £7 2s. 6d.; steel rails, heavy, £4 12s. 6d. to £4 15s.; light, £5 2s. 6d. to £5 12s. 6d.; Bessemer steel tin-plate bars, £4 12s. 6d. to £4 15s.; Siemens, £4 15s. Tin-plates: Makers' quotations for Bessemer steel, coke, 10s. 9d. to 11s.; Siemens, coke finish, 11s. to 11s. 3d.; ternes, per double box, 28 by 20 c., 19s. 3d., 19s. 9d. to 21s. 6d.; best charcoal, 12s. 9d. to 13s., according to finish of brand. Finished black plates, £8 to £8 10s.; Canadas, £7 to £7 10s. Block tin, £81 12s. 6d. to £82 5s. Lead, £13 7s. 6d.; Spanish, £13 5s. Coke continues in full demand at Cardiff and Swansea. Cardiff prices, 16s. 6d. to 17s. 6d. furnace; foundry, 18s. 6d. to 24s. 6d., according to brand. Patent fuel, 10s. 9d. to 11s., Swansea; 11s. to 12s., Cardiff. Iron ore firm and in good demand. The duty of 10 per cent. to be levied on Spanish ore is expected to increase the cost by about 1s. 9d. per ton to Welsh ironmasters in their pig output.

A number of cargoes of pitwood have arrived during the week, yet prices are fairly steady, 18s. 6d. being about the ruling figures at Cardiff.

P. and O. contracts for 80,000 to 100,000 tons best steam coal have just been issued—latest date, December 19th. The delivery is to be at the Royal Albert Dock, or at one of the London docks where the steamers may be lying. I note that in the public announcement the specification is either for North-country or Welsh coal. Probably the alternative was arranged lest labour trouble should be "on."

The sliding scale difficulty has, I hear, been readjusted, so that there is no obstacle in front to a good steady trade.

There was a considerable fire at the oil stores, Upper Cymmer Colliery, this week, and a good deal of damage was done. About a dozen men only were in the workings, and these were brought up safely.

An old Caerphilly furnace, called Furnace Blwn, with brick works, &c., is to be put up to auction this week.

The shipment of tin and black plates at Swansea during November totalled 11,558 tons, compared with 13,385 tons November 1897. As the details are of interest I add:—Russia took 4467 tons, as against 4862 for 1897; Sweden, nil, against 70 tons; Denmark, 364 tons to nil; Germany, 2284 tons to 1251 tons; Holland, 620 tons to nil; Belgium, 26 tons to nil; France, 886 tons to 1017 tons; Portugal, 455 tons to 262 tons; Italy, 846 tons to 709 tons; Austria, 120 tons to 67 tons; Straits, nil to 2261 tons; United States, 1490 tons to 2286 tons.

Last week shipments were low, owing to deficient tonnage. Shipment, 32,144 boxes; receipts from works, 47,069 boxes.

Market quotations are given firmly, and are imperative, owing to increased cost of materials. A full complement of mills has been going of late at the Beaufort, Duffryn, Upper Forest, Midland, Park, and at Players; three at Foxhole, four at Cardonnel, six at Cwmfelin, and eight at Pontardawe.

The question of organisation at Llanelly has been postponed for another week.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE position of the various iron trades in this country remains a thoroughly good one. The exceptionally brisk activity at the machine and wagon shops, the large amount of orders given out by the State Railways, and the liveliness that is still prevailing in the building line, render the present tone of the iron market hopeful and very firm. Pig iron, malleable iron, coal, and coke are meeting with such a vigorous demand that a certain scarcity has repeatedly been felt. Orders for bars and sectional iron come in freely and regularly. A good number of the contracts secured reach up to end of July of next year, and even further, and the works are fortunately in a position to demand higher prices, which are, as a rule, willingly granted, consumers being well aware of the fact that waiting longer would probably mean paying more.

Briskness prevails in almost every branch of the Silesian iron trade, home demand being specially strong in merchant iron and in rails and sleepers. Plates of all descriptions are likewise in very animated request, while the demand for sheets has been somewhat less lively during the week. The business done on foreign account is improving steadily, and quotations have met with advances in some instances. Girders, too, sell briskly, and at remunerative prices.

The convention of German locomotive shops, which would have expired in March of next year, has, according to the *Rhenish-Westphalian Zeitung*, been prolonged for a further five years.

Consumption in all classes of engine fuel has been increasing to such an extent that, although output has been raised as much as possible, production is hardly sufficient to meet the requirements. For house coal a comparatively moderate demand comes in, but this may soon alter, as the present summer-like weather cannot be expected to last long. During the first two weeks in November shipments of coal from Silesia amounted to 760,000 t., against 720,000 t. in the year before, and 620,000 t. in 1896.

In November of present year total shipments of coal and coke from the Ruhr district were 3,622,890 t., against 3,402,550 t.; from the Saar district, 532,690 t., against 543,070 t.; from Silesia, 1,501,210 t., against 1,403,280 t.; and from the three districts together 5,656,790 t., against 5,348,900 t. This shows an increase of 220,340 t. for the Ruhr district, and 97,930 t. for Silesia, while a decrease of 10,380 t. is noticeable for the Saar district. Total shipments of coal and coke during the eleven months of present year were 39,000,810 t. for the Ruhr district, against 36,755,540 t. for the corresponding period in the year before, 6,048,310 t. for the Saar district, against 5,764,270 t. in 1897, and 14,279,450 t. for Silesia, against 13,133,560 t. in previous year; increase thus being 6·1 per cent. for the Ruhr district, 5·0 per cent. for the Saar district, and 8·7 per cent. for Silesia.

Statistic figures given by the *Rhenish-Westphalian Gazette* state production of pit coal in Germany to have been, for 1897, 91,054,982 t. (1896 = 85,690,233 t., 1895 = 79,169,276 t.), total value amounting to M. 648,938,742 t., or M. 7·17 on an average per ton; for 1896, average value was M. 6·96 per ton; for 1895, M. 6·85 per ton. Average value for 29,419,503 t. brown coal produced in 1897 was M. 2·30 per ton; for 1896 it was M. 2·32, and for 1895 M. 2·38.

In Austria-Hungary the position of the engineering industries, and of the raw and finished iron business, is still languid. In tools and in hardware a falling off in demand was even reported last week, and the majority of the machine shops complain of securing but a very insufficient amount of orders. Official quotations, free Vienna, are:—Austrian and Styrian bars, 112fl. to 122fl.; Bohemian ditto, 110fl. to 114fl.; Hungarian ditto, 108fl. to 112fl.; girders, 111fl. to 125fl.; steel plates, 132fl. to 165fl.; heavy boiler plates, 150fl. to 180fl., all per ton. Styrian pig iron, free at works, is quoted 45½fl. to 50fl. or 51fl. per ton.

The demand for coal is moderate on the Austro-Hungarian market, and there is even a certain amount of weakness noticeable in house coal. Exports in brown coal remain strong.

The Austro-Hungarian commercial treaty with Japan has now been ratified by the Austrian Parliament. According to this treaty a duty of 10 per cent. of value will be put on kitchen furniture and other small articles of iron and steel, on lamps and parts of lamps in glass or metal, which are imported into Japan. Austria-Hungary has agreed to copper being imported duty free from Japan.

A fairly good iron business appears to have been done to Servia during this week and the week before, and prices are slowly tending in an upward direction. Fifteen wagons sectional iron, three ditto wire nails, have been imported from Hungary; ten wagons sectional iron from Bohemia, five wagons sectional iron, three ditto wire nails, and one ditto steel, from Carniola; three wagons nails, two ditto hardware and tools, from Germany.

A strong tone prevails in the Belgian iron industry, especially in the bar and plate department. Although official advances have not taken place, prices in nearly all branches are tending upwards.

Trade in the iron and allied industries of France continues lively, and shows considerable firmness as regards quotations.

A mining and railway office has recently been formed at Pekin, and a number of decrees have been issued by this office, which do not, however, refer to the Maudschurei, nor to Shautung or Lungtschan, as they would be likely to affect the international relations of these provinces. Henceforth concessions for building railways, which at the same time comprise mining privileges, will no more be granted. Owners of railways and mines have to build schools; three-fifths of the capital fixed for an undertaking is to be Chinese capital, and the permission of the mining office is required ere foreign capitalists are allowed to join. The control of undertakings is to remain in the hands of the Chinese. The railways have to pay 40 per cent., the mines 25 per cent. of profit to the Government. It must be added, that alterations are likely to be made in case these measures should, after publication, not meet with foreign consent.

According to the *Wiener Montan Zeitung*, Chili has been last year the principal consumer of coal exported from Hamburg, shipments to Chili amounting to 33,140 q. in 1897. The largest shipments of coke from Hamburg were those to Mexico and Australia.

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

THE Cape Colony Parliament has decided to grant an additional period of six months for the receipt of tenders for the new mail service between Cape ports and England. It has also resolved not to insert a new clause in the new contract making illegal the granting of rebates by the steamship companies to shippers. This long-talked-of attack upon the shipping ring in the Cape trade has therefore collapsed. The point of view from which the Cape Government regards the matter is that merchants and shipowners have a perfect right to make such mutual arrangements as suit themselves; and that a mail subsidy is paid for the quickening of passages, and not for the lowering of freights. Numerous petitions have been received by the Cape Parliament praying that Plymouth should be made the port of departure for the Cape mails instead of Southampton.

Indications point to an extensive development of deep-level enterprise on the Witwatersrand. Recent boring results have convinced engineers that the "dip" of the reef is not nearly so great as was formerly believed, and capitalists, acting upon this theory, are buying up properties more and more removed from the outcrop. Several farms on the south of the Rand are about to be proclaimed, and some of these cover ground from 10,000ft. to 25,000ft. from the outcrop. To the east of the Rand also fresh borings have lately been made with excellent results, the Main Reef series being struck at depths varying from 400ft. to 2000ft. There is thus every reason to anticipate a big revival of mining and engineering activity as soon as the financial aspect of affairs improves.

According to the report of Mr. Tudhope, the engineer of the Transkeian surveys, the length of the proposed Cape-Natal line from Medwa Station to Riverside Station is 324 miles, with a gradient of 1 in 60, and 320 miles with a gradient of 1 in 50. The cost is estimated at about £7000 per mile for a main passenger line of 60 lb. rails and wooden sleepers. The alternative route, which would avoid the town of Kokstad, would be 287 miles long, but would cost £7600 per mile.

The Orange Free State Government is inviting tenders for the construction of four new branch lines of railway.

There is some reason for hoping that the Cape Colony Government will at length act on the advice of the engineering experts it has consulted, and undertake a great scheme of irrigation works. The De Beers Company has offered to find security for a loan of £300,000 for irrigation undertakings in Griqualand West. Parliament has passed a resolution instructing the Government to negotiate with the Orange Free State, with a view to the utilisation of the waters of the Orange River.

The directors and engineers of the Roodepoort Central Deep Mine are taking some credit for the fact that they are commencing crushing with fifty stamps upon an expenditure of £250,000. Only one shaft has been sunk, which has now reached a depth of 1370ft. The plant is certainly an admirable one, and it is notable for the fact that the overflow water from the cyanide pits will be treated in spitzkasten, in order to recover the treatable material contained in it, and to minimise loss through soakage and evaporation.

LAUNCHES AND TRIAL TRIPS.

BRITTANIC; built by, Messrs. Wm. Gray and Co., Limited; to the order of, Messrs. W. H. Cockerline and Co.; dimensions, 330ft. by 48ft. 6in. by 24ft.; engines, triple-expansion, 24in., 38in., and 64in. by 42in., pressure 160 lb.; constructed by, Central Marine Engine Works; trial trip, December 8th.

CLARENCE, twin-screw mail and passenger steamer; built by, Messrs. Sir Raylton Dixon and Co., Limited; to the order of, Messrs. Elder, Dempster, and Co.; dimensions, 382ft. by 46ft. by 25ft. moulded; to carry 108 first-class and fifty second-class passengers; engines, triple-expansion, 21½in., 35in., and 59in. by 42in., pressure 180 lb.; constructed by, Messrs. The Wallsend Slipway Company, Limited; launch, December 12th.

CATALOGUES.

Shippey Bros., Limited, King-street, London, E.C.—Illustrated list of new designs in self-propelled electric carriages and motor cars constructed on the Riker system.

Louis Harper, Aberdeen.—Illustrated pamphlet on Harper's steel rope suspension bridges as erected over rivers at Hereford, Trentham, Grimsby, Keswick, and abroad.

The Electrical Storage Syndicate, Limited, Clifton Junction, Manchester.—Section A catalogue, devoted to lighting batteries, and Section C to yacht and launch lighting.

J. Sagar and Co., Halifax. Illustrated catalogue of wood-working machinery.—This is a thoroughly well got-up book of over 200 pages. The illustrations, binding, and paper, are all of the highest quality.

Garrard Manufacturing Company, Limited, Ryland-street, Birmingham.—Illustrated catalogue of pitch chains, wheels, and cycle accessories.

TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. Smith and Co., of Nottingham, have converted their business into a private limited company, and have registered same as "Smith's Injector Company, Limited."—Mr. John Milliken, late secretary of the Belfast and County Down Railway Company, has been appointed sole agent for Hartley and Teeters' light inspection cars, made by the Railway Cycle Manufacturing Company, of Hagerstown, Indiana, U.S.A.—On January 2nd, 1899, the offices of the Royal Meteorological Society will be removed to Princes Mansions, 70, Victoria-street, Westminster, S.W.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

2nd December, 1898.

25,413. LOOSE BAR FALSE FIREGRATE, R. Beacock, Leeds.
25,414. SMOKE EJECTOR, J. T. Hustwit, Batley, Yorkshire.
25,415. FOG-SIGNALLING APPARATUS, E. Wood, London.
25,416. CYCLE ANTI-VIBRATION HANDLE BARS, F. A. Barrow, London.
25,417. SWITCH for ELECTRIC CIRCUITS, J. Eck, London.
25,418. PAPER BAG, D. Elson, Northampton.
25,419. COOLING BUTCHERS' CELLARS, D. B. Walker, Glasgow.
25,420. BOOT CATCHER CLIP, G. Jones and J. Lee, Bradford.
25,421. SHIPS' DERRICKS, W. R. Lawson, London.
25,422. WRITING PEN, F. W. L. Sladen, Ringwould, near Dover.
25,423. RETAINING HEAT in TEAPOTS, M. and T. Innes, Manchester.
25,424. ROAD VEHICLE ACCIDENT PREVENTER, F. B. Tussaud, London.
25,425. CURTAIN POLES, G. Bowmar, London.
25,426. FINISHING COTTON FABRICS, R. Williams, Manchester.
25 427. CYCLE STAND, J. Challen, G. E. Asbury, and H. G. Baguley, Newark-on-Trent.
25,428. PLANT STAND, E. Hawkins, Sidcup, Kent.
25,429. LAMP STAND, G. Chumley, London.
25,430. STRETCHING BOOTS, E. Soutter and F. R. Baker, Birmingham.
25,431. TREATING ORES, T. Twynam and F. W. Harbord, Egham, Surrey.
25,432. ROTARY ENGINES, L. C. Docker.—(*H. Pearse, Argentine Republic.*)
25,433. FREE WHEELS for CYCLES, F. Crosby, London.
25,434. HOLDERS for CLAY PIGEON TRAPS, F. Greener, Birmingham.
25,435. BICYCLE SUPPORTS, L. C. Docker.—(*H. Pearse, Argentine Republic.*)
25,436. BOAT-LOWERING APPLIANCES, F. R. Patey, Glasgow.
25,437. CASEMENT-OPENING MECHANISM, J. H. Cartland, Birmingham.
25,438. DRIVING GEARS for CYCLES, J. H. Schofield, Manchester.
25,439. PROPULSION of CYCLES, F. A. Wodehouse, Birmingham.
25,440. BREECH-LOADING FIRE-ARMS, C. H. Laubenburg, C. B. Engels, and W. Field, Birmingham.
25,441. UMBRELLAS, A. and W. Hill, Bath.
25,442. BEDSTEADS, J. E. Hoskins and G. R. Payne, Birmingham.
25,443. PLUMBERS' JOINTS, T. Cooper, Birmingham.
25,444. HARNESS SADDLES, T. E. Adcock, Birmingham.
25,445. ATTACHING PANELS to RIDING SADDLES, J. Wood, G. Power, T. Cooper, E. Sammons, R. M. Bunney, W. G. Trezise, A. H. Stanley, H. Turner, J. Davis, W. A. Webster, E. W. Shelley, and T. H. Dexter, Birmingham.
25,446. FOOTBALL BOOTS G. H. Hickson, Stockton-on-Tees.
25,447. PUDDING BOWLS, G. J. Perry and J. Gittelsohn, London.
25 448. METALLIC PACKING, J. Watt and W. A. Davies, Liverpool.
25,449. ACETYLENE GAS GENERATORS, W. J. Rodwell, London.
25,450. BOXES, P. S. Brown, Glasgow.
25,451. BALLASTING TANKS for VESSELS, J. Kay, Glasgow.
25,452. GAS GENERATORS, H. E. Smith and W. Doman, London.
25,453. CHECK BOOKS, R. G. Hook, Liskeard, Cornwall.
25,454. WELL PUMPS, J. Klein and B. Brunch, Liverpool.
25,455. VELOCIPEDE SUPPORTS, W. Wegman-Bossert, Glasgow.
25,456. CALL-ALL, W. T. Dumbleton, Nuneaton.
25,457. SHOW CARDS, F. Grainger and G. F. Ashley, Bradford.
25,458. SHOES, F. D. Gray, London.
25,459. SECURING SCAFFOLDING, A. G. Thomas, Bristol.
25,460. COMPRESSED BOOT PRESERVERS, A. Warren, Bristol.
25,461, SPRAYS, C. J. Whittaker and W. C. Bryant, Liverpool.
25,462. APPARATUS for TREATING FRUIT, J. E. B. Wilson, London.
25,463. WEIGHING GRANULATED SUGAR, J. J. Marshall, London.
25,464. CARRIER, C. H. Shipman, Birmingham.
25,465. EXTENSION SHOES, A. Ivey and E. Wienert, London.
25,466. PROPULSION of AERIAL VESSELS, T. Moy, London.
25 467. HAIR COMB and CLEANER, A. H. Cotton, London.
25,468. CONVEYING CYCLES, W. H. Crutchley, Birmingham.
25,469. SEWING MACHINES, J. Crook and E. Whitehead, London.
25,470. CONNECTING ANIMALS to VEHICLES, T. H. Brigg, London.
25,471. CONNECTING ANIMALS to VEHICLES, T. H. Brigg, London.
25,472. TUBULAR BOILER, W., J., and E. Rockhill, London.
25,473. SUBMARINE SOUND TRANSMITTER, C. H. Prichard, London.
25,474. LEG COVERING, P. H. Davy, London.
25,475. NITROGEN COMPOUNDS, A. Frank and N. Caro, London.
25,476. WATER-INJECTING APPARATUS, E. Klein, London.
25,477. TREATING METALLIC ALLOYS, C. L. C. Barlow, London.
25,478. UMBRELLAS and SUNSHADES, J. Jeffery, London.
25,479. IGNITER for GAS ENGINES, F. W. Canfield, London.
25,480. BALL-BEARINGS for WHEELS, W. P. Thompson. —(*H. C. S. Schmidt, Germany.*)
25,481. COOLING ORES, W. P. Thompson.—(*P. Argall, United States.*)
25,482. CORD ATTACHMENT, M. Stelfox, Liverpool.
25,483. SPRING MATTRESSES, Hoyland and Smith, Limited, and J. W. Hoyland, Birmingham.
25,484. DOOR HANDLES, A. J. White, London.
25,485. TYPEWRITING MACHINES, H. H. Lake.—(*Manhattan Typewriter Company, United States.*)
25,486. SEAT for SEWING MACHINES, E. A. G. Hamlin, London.
25,487. SEWING MACHINES, J. Cudel, London.
25,488. BAND for CIGARS, G. J. Galloway, London.
25,489. HAT CLIP, N. Palmer, London.
25,490. WINDOWS, E. J. Preston and G. E. Jakeman, London.
25,491. TURTLE WINE, A. H. Deakin and T. F. Garrett, London.
25,492. OPENING ACETYLENE LANTERNS, H. J. Haddan. —(*A. Frank, Germany.*)
25,493. REGULATING GAS GENERATION, H. J. Haddan. —(*A. Frank, Germany.*)
25,494. SCREW CONNECTING-BOLTS, J. Exenberger and K. Thomas, London.
25,495. BALL and ROLLER BEARINGS, J. A. W. O. Torrens, London.
25,496. FRICTION GEAR, Stothert and Pitt, Limited, and W. Baxter, London.
25,497. MACHINE GUNS, B. W. Trigg and A. F. Woodley, London.
25,498. HARVESTERS, J. MacPhail, London.
25,499. DRESS FASTENER, J. Sample, London.
25,500. CATTLE-STALL FITTINGS, G. W. Sivewright, London.
25,501. TYPOGRAPHIC MACHINES, W. L. Wise.—(*The Composite Type Bar Co., United States.*)
25,502. SIGNALS, S. P. Wood, London.
25,503. CHANGING the SPEED of MOTOR-CARS, C. Martel, London.
25,504. BALL-BEARINGS, K. Mizgalski, London.
25,505. CARBONATING BEERS, H. Vuylsteke, London.
25,506. RAILROAD MAP and TIME-TABLE, L. Rabow, London.
25,507. VESSEL CLOSURE, O. Staud, London.
25,508. DIAZO DYESTUFFS, S. Pitt.—(*L. Cassella and Co., Germany.*)
25,509. GRIPPING COLLAR, G. C. Marks.—(*L. Dechaux and R. Andreau, France.*)
25,510. COOLING BEER, H. Vuylsteke, London.
25,511. BILLIARD-CUE REST, A. M. Parsons, London.
25,512. METAL CANS, A. M. Parsons, London.

3rd December, 1898.

25,513. CIRCULATING FRYING PAN, E. Horley, Ditton, near Widnes.
25,514. MICROMETER GAUGE, W. Sydenham, Bristol.
25,515. ATTACHING SIGHTS to SMALL ARMS, L. B. Taylor, Birmingham.
25,516. FOOTBALL PUMP, J. Shaw and G. Dixon, Willington-on-Tyne.
25,517. CHURN LIDS, H. Fearncombe and Co., Limited, and G. Farlow, Wolverhampton.
25,518. TRUCKS, W. Harber. Derby.
25,519. ADVERTISING, B. Bell. Newcastle-on-Tyne.
25,520. BOTTLES, T. Fraser, Manchester.
25,521. BRAKES, J. R. Howard, Willesbrough, near Ashford, Kent.
25,522. LETTING-OFF MOTION of LOOMS, D. Riley, Bradford.
25,523. PAINT CANS, R. A. Matthews, Birmingham.
25,524. SCREW STOPPERS for BOTTLES, L. Vallet, Liverpool.
25,525. TREATING YARN, J. Major and T. J. Wood, Manchester.
25,526. ROTARY POWER ENGINE, A. Boyd, Stockton-on-Tees.
25,527. DRIVING GEAR for VELOCIPEDES, H. Moore, London.
25,528. ROLLER for NAPPING MACHINES, F. Müller, Glasgow.
25,529. BILE SCUTTLES for STEAMERS, &c., A. Phillips, Glasgow.
25,530. GLOVE, H. N. Stroud, Leicester.
25,531. BRACKET for CARRIAGE LAMPS, H. Cassey, jun., Salisbury.
25,532. BICYCLES, E. B. Killen, Glasgow.
25,533. FIRELIGHTER, R. Young, Glasgow.
25,534. MACHINE for CLEANING KNIVES, E. F. J. Bille, Glasgow.
25,535. ATTACHMENT to LATH and PLASTER, L. Barlow, London.
25,536. CYCLE DRIVING GEAR, W. P. Thompson.—(*H. Fried, Germany.*)
25,537. GAS ENGINES, W. Thompson.—(*Bluhm and Co., and J. Bauer, Germany.*)
25,538. BACK-PRESSURE VALVES, C. A. G. Storz, Liverpool.
25,539. BEDS, Hoyland and Smith, Limited, and W. J. Hayland, Birmingham.
25,540. BRUSHES, J. Vale, Birmingham.
25,541. MANUFACTURING CORKS for BOTTLES, S. Kemp, London.
25,542. HOOKS for HANGING WATCHES, C. Alan-Thwaite, Glasgow.
25,543. LOCKS, C. Davis, London.
25,544. RAILWAY-SIGNAL APPARATUS, W. R. Sykes, sen., London.
25,545. CORD HOLDERS, J. Altmann, London.
25,546. METALLISATION of SURFACES, W. A. P. Werner, London.
25,547. ROTARY ENGINE, J. H. Lee, London.
25,548. APPARATUS for WITHDRAWING SHAVINGS and DUST, M. R. Ruble, W. I. Adams, and C. R. Iorns, London.
25,549. APPARATUS for RENOVATING FEATHERS and WOOL, M. R. Ruble, W. I. Adams, and C. R. Iorns, London.
25,550. MACHINE for MAKING CAPSULES, A. T. Wedelin, London.
25,551. WHEELS and TIRES, E. A. Fruton, London.
25,552. VARYING SPEED, W. D. Rowlingson.—(*La Société Diligeon et Compagnie, France.*)
25,553. CURLING IRON, G. Neiss, London.
25,554. MANUSCRIPT HOLDER, R. Haddan.—(*O. Siedentopf, Germany.*)
25,555. VEHICLE LAMPS, J. C. Walker and J. Fraser, London.
25,556. LETTER-RECEIVING BOXES, E. Fielden, Manchester.
25,557. LAMPS, C. L. Kettridge, London.
25,558. CONCENTRATING SULPHURIC ACIDS, R. England, London.
25,559. NECKTIES, F. Thesk. London.
25,560. MNEMONIC MEANS. A. Hauser, London.
25,561. CLOSETS. J, Oppelt, London.
25,562. CURTAIN SUSPENDER, H. Seyfarth, London.
25,563. PIANOFORTES, C. Smith and W. Benson, London.
25,564. KNIFE HOLDER, J. Cangina, London.
25,565. WATER-CLOSET SEATS, M. Page, London.
25,566. AZO COLOURING MATTERS. O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
25,567. TRANSMITTING MOTION, Siemens Brothers and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
25,568. EXPLOSIVES, G. von Geldern-Egmond, London.
25,569. PULLEYS, R. Machold, London.
25,570. COIN-FEED DELIVERY APPARATUS, E. Olivo, London.
25,571. BANDS for HAIR-BRUSHING MACHINERY, F. Bilger, London.
25,572. BRAKES for VELOCIPEDES, J. H. F. Reid, London.
25,573. PENHOLDER and PEN WIPER, W. Jackson, London.
25,574. RETAINING HATS on WEARER'S HEADS, P. L. Deighton, London.
25,575. PRISMATIC GLASS REFRACTORY MEANS, F. T. Brierley, London.
25,576. VALVE WORKING, Emanuel and Sons, Limited, and T. Crump, London.
25,577. VALVES for INFLATING TIRES, H. Oliver, London.
25,578. SADDLE SUPPORTS for BICYCLES, F. Nicolas, London.
25,579. ROLLING OUT HOLLOW BODIES, O. Klatte, London.
25,580. ROLLING "ENDLESS" ARTICLES, O. Klatte, London
25,581 SECURING COVERS of PACKING CASES, J. Fullbrook, Slough, Bucks.

5th December, 1898.

25,582. RULERS, M. V. Pragh, London.
25,583. MARKING GAUGE, J. McLean and F. C. Elliott, London.
25,584. ACETYLENE GAS GENERATORS, W. J. Dossetter, London.
25,585. FASTENING BOOTS, J. E. Loach and W. H. Gaines, Halifax.
25,586. CHEESE CUTTER, L. Lord and A. R. Miller, Swindon.
25,587. REELS of MOWING MACHINES, G. Vutz, Cologne, Germany.
25,588. AUTOMATIC GAS REGULATORS, G. Tillotson, Shipley, Yorks.
25,589. SEWING MACHINES, W. H. Dorman, Stafford.
25,590. MEANS for TRANSPORTING MEAT, W. Taylor, Liverpool.
25,591. INDIA-RUBBER WATERPROOF FABRIC, I. Frankenburg, Manchester.
25,592. CUT-OUT for ELECTRIC CIRCUITS, F. W. Heaton and H. Smith, Manchester.
25,593. WATERPROOF GARMENTS, I. Frankenburg, Manchester.
25,594. APPLIANCE for BINDING TRAM RAILS with COPPER BONDS, D. F. Sugrue, D. James, and G. Mitchell, Swansea.
25,595. CYCLE HORN FOOT BLOWER, C. H. Shacklock, Wolverhampton.
25,596. TENSION SPOKES, F. P. Headley and A. Law, Wolverhampton.
25,597. INJECTORS, H. Walraf and J. Colson, Leicester.
25,598. OPENING and SCUTCHING MACHINES, N. Ramberg, Manchester.
25,599. ELASTIC BEARINGS for SPINDLES, N. Ramberg, Manchester.
25,600. COAL WASHERS, A. E. N. and S. N. Yeadon, Leeds.
25,601. TILT HAMMERS, J. W. Kilner, Leeds.
25,602. PLATES for ROOFS, M. Wilbertz, Cologne, Germany.
25,603. STEAMER POSITION INDICATOR, D. McNeill, Arnadam, Argyleshire.
25,604. PROTECTING PROPELLER SHAFTS, A. MacLaine, Belfast.
25,605. AUTOMATIC PAPER FEEDERS, J. R. Vellacott, London.
25,606. STARTING ENGINES, W. H. Bird and H. L. Davis, Leytonstone, Essex.
25,607. GUNS for WAR PURPOSES, G. H. Laxton, London.
25,608. HANDLE-BARS for BICYCLES, W. J. Hodgkinson, London.
25,609. UMBRELLA RING, R. Lee, London.
25,610. TOILET PAILS, G. Toesten, London.
25,611. PNEUMATIC MUSIC LEAF TURNER, C. Milne, London.
25 612. GAMES, G. Cole, London.
25,613. BLANK BORDER PAGES for LETTERPRESS PRINTING, C. Hassam, London.
25,614. COLOURING MATTER, G. W. Johnson.—(*Kalle and Co., Germany.*)
25,615. FOLDING BOXES, G. Canler and T. Haines, London.
25,616. SPANNER, E. J. Wright, Southend-on-Sea.
25,617. BOTTLE STOPPER, A. J. Boult.—(*C. N. Brisco, United States.*)
25,618. DRAIN PIPES, R. Whichello, London.
25,619. BATHS, A. J. Boult.—(*J. Weber, Germany.*)
25,620. IRIDESCENT PAPER or MATERIAL, P. Piette, London.
25,621. CYCLE SPEED GEARS, A. J. Boult.—(*E. Martin, France.*)
25,622. GUARDS for CIRCULAR SAWS, G. Porters, London.
25,623. BAND SAW MACHINES, A. Ransome, London.
25,624. COMPOSITION for CLEANSING, &c., J. Foster, London.
25,625. READY RECKONER, H. E. Newton.—(*W. S. Andrews and J. Boock, New South Wales.*)
25,626. BOTTLES for AERATED WATERS, E. A. Braubach, London.
25,627. LIFE-SAVING APPARATUS, H. H. Lake.—(*B. Carlsen, Norway.*)
25,628. FLEXIBLE METALLIC TUBES, R. E. Liesegang, London.
25,629. HYDROCARBON OIL COMBUSTION, T. Tomlinson, London.
25,630. WORM GEAR, R. J. Hickton, London.
25,631. CYCLE and MOTOR CAR DRIVING GEAR, W. P. Thompson.—(*Bluhm and Company and J. Bauer, Germany.*)
25,632. LAMPS, J. S. Blackwell and W. A. Charles, London.
25,633. BUCKLES for BELTS, BRACES, &c., J. P. Cooke, Liverpool.
25,634. COLOURING MATTERS and INTERMEDIATE PRODUCTS, G. B. Ellis.—(*La Société Chimiques des Usines du Rhône, anciennement Gilliard, P. Monnet, et Cartier, France.*)
25,635. SHIPS' LOG APPARATUS, T. F. and T. S. Walker, London.
25,636. DRESS SHIELDS, G. S. Roberts, London.
25,637. CYCLES, A. Provesnic, London.
25,638. COATING PAVING-BLOCKS, J. McSweeney, London.
25,639. BAR for BICYCLE SADDLES, C. D. Parker, London.
25,640. COMPRESSING AIR for SIGNALLING, L. Morey, London.
25,641. CARD ADVERTISING DEVICE, T. G. Edwards, London.
25,642. PURIFYING SACCHARINE LIQUORS, O. Imray.—(*Ranson's Sugar Process, Limited, France.*)
25,643. BLACK DYESTUFFS for RAW MATERIAL, C. D. Abel.—(*The Actiengesellschaft für Anilin Fabrikation, Germany.*)
25,644. DYESTUFF DIRECTLY DYEING COTTON, C. D. Abel.—(*The Actiengesellschaft für Anilin Fabrikation, Germany.*)
25,645. WOVEN FABRICS, C. D. Abel.—(*J. Schärtges, Germany.*)
25,646. TYPEWRITING MACHINES, C. T. Powers, London.
25,647. CYCLE-DRIVING MECHANISM, W. J. Thompson, London.
25,648. PULLEYS, S. H. Dening and A. M. Phillips, London.
25,649. LOWERING APPARATUS for MINES, D. Davy, London.
25,650. PRODUCING DISAZO COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
25,651. COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
25,652. SUSPENDING KEYS, A. W. Pyke, London.
25 653. INCANDESCENCE MANTLES, W. L. Voelker, London.
25,654 INCANDESCENT GAS BURNERS, A. B. Griffin, London.
25,655. SEPARATING ORES from GANGUE, W. Jamieson, London.
25,656. APPARATUS for MANUFACTURING CALCIUM CARBIDE, H. Maxim, London.
25,657. ELECTRICAL SIGNALLING DEVICES, L. Jacob, London.
25,658. ADVERTISING APPARATUS, J. A. Kennedy-McGregor, London.
25 659. VEHICLE WHEELS, G. A. Burwell, London.
25,660. APPARATUS for DRYING OFFAL, J. F. Johnstone, London.
25,661. BALL CASTORS, G. K. Bentley, Ontario, Canada.

6th December, 1898.

25,662. LOCKS, I. Constable and W. Sawbridge, Wolverhampton.
25,663. PNEUMATIC SOCK, R. Sheppard, St. Albans, Herts.
25,664. GAS TAPS, H. J. Yates, Birmingham.
25,665. BELT FASTENERS, W. M. Harris, Birmingham.
25,666. CLAMPS for HOLDING GLASS PLATES, J. Hulls Birmingham.
25,667. ELECTRICAL RESISTANCE COILS, S. W. Cuttriss, Leeds.
25,668. LOCKING DEVICE for CYCLES, F. Richmond, Burnley.
25,669. RIVETING MACHINE, J. Fielding, Gloucester.
25,670. ELECTRIC INDUCTION APPARATUS, T. C. Kinraide, London.
25,671. TOY, J. A. Udden, Kingston-on-Thames.
25,672. CAN-OPENERS, R. W. Clarke, Kingston-on-Thames.
25,673. PROPELLERS, E. S. Beck, Kingston-on-Thames.
25,674. OIL ENGINES, J. Southall, Worcester.
25,675. CHIMNEY TOP, J. Peers, Warrington.
25,676. SECURING CERAMIC WARE, J. Kent, Stoke-on-Trent.
25,677. PROPELLING SHIPS, V. Ranalli, Manchester.
25,678. VELOCIPEDES, J. R. Topham, Nottingham.
25,679. DEVICE for INDICATING when LIQUOR has been EXTRACTED from BOTTLES, L. McFarlane, Glasgow.
25,680. VENTILATOR, G. Taylor, Glasgow.

25,681. EXTRACTING NAPHTHALENE from COAL GAS, W. Irwin and J. P. Leather, Manchester.
25,682. CYCLE TIRES, H. Moon and S. Bunting, Birmingham.
25,683. TRAPS for DRAINS. E. A. Green, Leeds.
25,684. BOOT HEELS, B. Martin, Birmingham.
25,685. POLISHING MACHINES, F. F. Ellis and The Oneida Community, Limited, London.
25,686. EXTRACTING LIQUID from SEWAGE, C. J. Lomax, Manchester.
25,687. CYCLE TIRES, E. H. Craggs and W. Cockburn, Stockton-on-Tees.
25,688. COLLAR STIFFENING, A. Nicholson and J. Hall, Manchester.
25,689. DRILLING TUBES, S A. and W. H. Jackson, Salford, Lancs.
25,690. ASHPIT DOORS, R Brown, Belfast.
25,691. JOINTS, W. and T. D. Bayliff, and B. Draper, Liverpool.
25,692. WAGONS, E. Carter and W. H. Holland, Liverpool.
25,693. ELASTIC WHEELS for VEHICLES, S. Greenwood, Liverpool.
25,694. CYCLE SHIELDS, W. Jackson, Kingston-upon-Hull.
25,695. SIGNAL for PASSENGERS of VEHICLES, C. Brawn, London.
25,696. LIGHTING CIGARS, &c., W. Wye and J. Miller, Leicester.
25,697. DRYING and PURIFYING AIR, A. Millar, Glasgow.
25,698. RAIN EXCLUDERS, W. and H. Holden, and J. W. Clegg, Manchester.
25,699. STOVES for HEATING AIR, F. Swindells, Manchester.
25,700. INFLATABLE TUBE for WHEELS, J. H. Stevenson, Edinburgh.
25,701. PEGS, T. Longsdale, Holcombe Brook, near Ramsbottom, Lancs.
25,702. FORCED DRAUGHT for FURNACES, J. B. Houston, Vancouver.
25,703. FURNACE, J. F. Webb, J. Chapman, and J. E. Lilley, London.
25,704. TIRES, W. H. Moss and J. H. Rowse, Birmingham.
25,705. LEAD COATING for METAL SURFACES, A. J. Boult.—(*G. H. Clamer, United States.*)
25,706. DRIVING CHAIN ADJUSTMENTS, H. Belcher and F. Esom, London.
25,707. TURNING the JOURNALS of AXLES, C. H. Laverick, London.
25,708. CONSUMING FURNACE SMOKE, H. Schofield and O. P. Macfarlane, London.
25,709. CARDING ENGINES, P. Kelly, Cross Hills, near Keighley.
25,710. DYNAMOS, J. E. Fuller, London.
25,711. URINAL STALL, A E. Anderson, Northampton.
25,712. BICYCLE, H. Williams, Birmingham.
25,713. PROPELLERS for SHIPS, G. Cardosa, Birmingham.
25,714. PROTECTING TROUSERS BOTTOMS, R. E. Siegert, London.
25,715. COOKING APPARATUS, E. A. Braubach, London.
25,716. HIGH-SPEED ENGINES, E. E. Wigzell, London.
25,717. CASE for HOLDING CIGARETTES, B. Bloom, London.
25,718. CHRONOSTEREOSCOPE, C. S Lumley, London.
25,719. PIANOFORTES, A. Modlik, London.
25,720. CYCLES, J. E. Tolson, Dewsbury.
25,721. COOKING APPARATUS, W. Holmes and C. R. Stevens, London.
25,722. MINERS' SAFETY LAMP, W. Best, London.
25,723. STEAM GENERATORS, J. A. Miller, London.
25,724. GARMENT-FASTENING DEVICE, H. H. Lake.—(*J. V. Washburne, United States.*)
25,725. COMPRESSED AIR and GAS PUMPS, H H. Lake.—(*The Ingersoll-Sergeant Drill Company, United States.*)
25,726. VICE, R. S. Brown, London.
25,727. FLUID COMPOSITION, H. H. Lake.—(*H. W. Grimsdale, Victoria.*)
25,728. ADJUSTABLE STOCK and WRENCH, J. C. Ward, London.
25,729. CONTRIVANCE for DISPENSING with BABIES' NAPKINS, F. Potthoff and E. Rückel, London.
25,730. LOCK, P. Kossov, W. Wischew, and P. Sofronow, London.
25,731 KNITTING MACHINES, H. H. Lake.—(*J. E. Rowe and L. A. Bentz, United States.*)
25,732. CYCLE TRACKS, C. Dufaux, London.
25,733. WIRE-DRAWING MACHINES, C. Weyhmann, London.
25,734. BATTERIES, W. Schlothauser and A. E. Preece, London.
25,735. MOTOR VEHICLES, J. Roots and C. E. Venables, London.
25,736. BOILERS, O. Imray.—(*W. C. Temple, United States.*)
25,737. STEADYING GUNS on SHIPBOARD, B. Tower, London.
25,738. HOLDER for CIGARETTES, W. K. Ferguson, London.
25,739. TIRES, E. Kempshall, London.
25,740. TIRES, H. H. Lake.—(*Vereinigte Gummiwaaren—Fabriken Harburg-Wien, vormals Menier—J. N. Reithoffer, Germany.*)
25,741. CARRIAGES DRIVEN by ENGINES, T. F. S. Tinne, London.
25,742. FURNACES, A. Piat, London.
25,743. PRINTING MACHINES, H. E. Newton.—(*R. Hoe, United States.*)
25,744. SHIPS' LOGS, J. and J. L. Blias, London.
25,745. SMALL ARMS, F. E. Chilton and H. W. Roberts, London.
25,746. HEATING OVENS, F. and L. F. Christy, London.
25,747. INCANDESCENT ELECTRIC LAMPS, J. W. Swan, London.
25,748. HYPOCHLORITE of SODA, M. Muspratt, E. S. Smith, and The United Alkali Company, Limited, London.
25,749. MULTI-COLOUR PRINTING, W. T. Hearn, London.
25,750. GAS-EXTINGUISHING APPARATUS, P. Barnikel, London.
25,751. OPERATING SEWING MACHINES, J. Cudel, London.
25,752. OPERATING ELECTROMETERS, G. L. Addenbrooke, London.
25,753. TRAVELLING TRUNKS, J. and R. J. Foot, London.
25,754. ATTACHING BUCKLES to STRAPS, J. and R. J. Foot, London.
25,755. SKIPPING ROPES, G. A. Beckh, London.
25,756. PIPES, J. H. Carte, London.
25,757. FLOOR CLOTH, E. Edwards.—(*F. Gatzsche, Germany.*)
25,758. BOOT SOLES and HEELS, E. Edwards.—(*F. Gatzsche, Germany.*)
25,759. PUZZLE, J. Kynaston, London.
25,760. PRODUCING COLOURED PHOTOGRAPHS, E. Mertens, London.
25,761. VACUUM PUMPS, A. Berrenberg, London.
25,762. DOUBLE-ACTING VACUUM PUMP, A. Berrenberg, London.
25,763. A BAG HOOD, L. Dickinson, London.
25,764. BREAKING SURFACE CONTACT on ELECTRICAL TRAMWAYS, W. F. Stamp, London.
25,765. CYCLE TIRES, C. G. Krieger, London.
25,766. BICYCLE HANDLES, J. and C. Udall, London.
25,767. CYCLISTS' SHOES, J. and C. Udall, London.
25,768. PESSARY and INSTRUMENT for APPLYING the SAME, E. A. Butler, London.
25,769. SUSPENSION BRIDGES, W. P. Thompson.—(*The Maschinenbau Actiengesellschaft Nürnberg, Germany.*)
25,770. BARRELS, O. H. P. Cornell, Liverpool.
25,771. PRODUCING GAS, H. S. Elworthy and H. Lane, London.
25,772 DRYING and PAINTING COMPOUND, E. O. Tatlin, London.
25,773. CAMERA STANDS, T. Whiles and T. Thornton, London.
25,774. DECORATING TIN-PLATE, J. Jones and G. T. Oliver, Liverpool.
25,775. COLLAPSIBLE BOXES, A. Silbiger, Liverpool.
25,776. HAIR-PINS, M. J. Brown, Manchester.
25,777. HOLDERS for MOSQUITO CURTAINS, S. W. Silver and W. Fletcher, London.
25,778. MATTRESSES, &c., F. Hodes and E. Broel, London.
25,779. FOOD PREPARATIONS, H. Ballantyne and The Hovis-Bread Flour Company, Limited, London.

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25,780. MACHINERY for DYEING FABRICS, P. Villette, London.
25,781. BICYCLES, J. E. Harvey and R. B. Helliwell, Liverpool.
25,782. ROTARY EXPLOSIVE MOTOR, J. W. Strutt, Ipswich.
25,783. THEATRICAL STAGE MAKE-UP BOX, F. Whale, London.
25,784. EXTRACTING METALS from ORES, J. Fraser, London.
25,785. RETAINING APPARATUS, H. Daw, Sevenoaks, Kent.
25,786. ATTACHING TIRES to WHEELS, T. F. A. Ash, Gnosall, Staffs.
25,787. SIGHT-FEED LUBRICATOR, T. Parkinson, Blackburn.
25,788. GUARD for TRAMCARS, F. A. B. Daly, Dublin.
25,789. NOZZLE HOLE in PRESS CLOTHS, A. E. Williams, Liverpool.
25,790. METALLIC PACKING, E. T. Ferrier, Cardiff.
25,791. ROTARY SQUEEZER for PUDDLED IRON, W. Lees, Ashton-under-Lyne.
25,792. SHACKLES or HOOKS for HARNESS, S. J. Prescott, London.
25,793. COUPLINGS for ROLLING STOCK, S. J. Prescott, London.
25,794. MULTIPLYING BRICKS, S Barwise, Derby.
25,795. SHOULDER-BRACES, E. Rouse, London.
25,796. TWINE BOX, R. Robertson and C. C. Elliott, Gateshead-on-Tyne.
25,797. OINTMENT for MEDICINAL PURPOSES, W. M. Gibson and J. Miles, Keighley.
25,798. PERMANENT WAY CHAIR KEYS, G. Edes, Liverpool.
25,799. SPITTOON HOLDER, F. Lohnert, Liverpool.
25,800. OIL ENGINE IGNITING DEVICES, C. G. Beechy, Liverpool.
25,801. TOPS for SPINNING MACHINES, J. Macfie, Glasgow.
25,802. The "RAPID" ENVELOPE, A. D. Davies.—(*H. T. Davies, Victoria.*)
25,803. MOUNTING FOLLOWERS within LOCK CASES, W. Simkins and C. Hadley, Wolverhampton.
25,804. MATCH-BOXES, W. Pearce and H. J. Cooper, Birmingham.
25,805. RAILWAY PLATFORM TROLLEYS, W. Daniels, Manchester.
25,806. PORTABLE PHOTOGRAPHIC STUDIO, A. S. Levi, Manchester.
25,807. DRIVING GEAR of AUTO-CARS, J. K. Starley, Coventry.
25,808. SURVEYING INSTRUMENTS, T. A. O'Donahue and J. Halden, Manchester.
25,809. TAG FASTENERS, G. F. Morse and G. H. Holgate, London.
25,810. BOXES, T. Baxter, Leicester.
25,811. DETACHABLE PNEUMATIC TIRES, S. R. Stone, Birmingham.
25,812. TREADLE TRAP for MICE, &c., J. H. Atkinson, Leeds.
25,813. CATCHES for DOORS, The Honourable R. W. H. Bodney, Bristol.
25,814. RECORDING MECHANICAL MOTION, G. J. Gibbs, Bradford.
25,815. SAFETY BICYCLES, H. J. Peers, Birmingham.
25,816. CARRYING CARCASES of CATTLE, W. and J. Jack, Glasgow.
25,817. ROLLER EYELETS, R. Gordon, London.
25,818. COPYING INK, W. Ralston, Glasgow.
25,819. FOG-SIGNALLING APPARATUS, R. Stanners, Glasgow.
25,820 CYCLE DRIVING MECHANISM, B. H. C. Walker, Liverpool.
25,821. EXHAUST of GAS ENGINES, H. N. Bickerton and H. W. Bradley, Manchester.
25,822. MECHANICAL MUSTARD-POT, F. Foerster, Baden, Germany.
25,823. DYEING WOOL YARNS, J. Rhodes, Bradford.
25,824. PREPARING CARTRIDGE CASES, D. Scase, Framlingham, Suffolk.
25,825. STOP FISHING REEL or WINCH, M. Gray, Cardiff.
25,826. BOATS' ROWLOCKS, W. T. Lord, London.
25,827. REVERSING POWER CRANKS for CYCLES, H. J. Owers and W. T. Lord, London.
25,828. REVERSING PROPELLER for STEAMSHIPS, A. H. Lacock, London.
25,829. PNEUMATIC ROCKING CHAIRS, H. Johnson.—(*T. H. Johnson, Russia.*)
25,830. COUPLING WIRE ROPES, L. Gooder, London.
25,831. INSTRUMENT for PIERCING PAPER, T. G. Day, London.
25,832. CYCLE BASKETS, B. Marcus, London.
25,833. AUTOMATIC ENTERTAINING MACHINE, R. H. and J. F. Shaw, Manchester.
25,834. FUNNEL and MEASURE, W. R. J. Forsyth, Folkestone
25,835. FLOAT VALVES, F. S. Thorn and C. Hoddle, London.
25,836. CYCLE CHAIN-ADJUSTING DEVICE, H. Ganswindt, London.
25,837. STOPPERING BOTTLES, C. Haschké, London.
25,838. EXPLOSIVES, J. E. Evans-Jackson.—(*U. Alvisi, Italy.*)
25,839. HOT-AIR BRICK, F. du Bois, London.
25,840. VELOCIPEDES, E. A. Mepham, London.
25,841. WOOD SCREWS, A Grattan, London.
25,842 FEEDING-BOTTLES for INFANTS, A. Grattan, London.
25,843. MOUSE-TRAPS, D. O. Jones, London.
25,844. SAFETY WAGON or CARRIAGE, J. Emden, London.
25,845. SHAKING TABLES, J. G. Boyes, London.
25,846. TELESCOPES, A. A. Common, London.
25,847. DRIVING MECHANISM of CYCLES, J. G. de Groot, London.
25,848. SUBMERGING SUBMARINE BOATS, E. Oldenbourg, London.
25,849. ERECTING DWELLING-HOUSES, J. Hathway, London.
25,850. ELECTRIC LAMPS, J. E. Barnard, London.
25,851. RHEOSTATS, G. Whiteley and S. W. Marshall, London.
25,852. CLEANING COAL, C. Burnett and H. T. Newbigin, London.
25,853. STORING GAS, W. P. Thompson.—(*G. Thuillier and A. Aubry, France.*)
25,854. GARMENTS, W. P. Thompson.—(*W. C. Möller, Norway.*)
25,855. OIL-FILTERING APPARATUS, S. Schönfeld, London.
25,856. TUBE for CONTAINING FLUIDS, F. Stohr, London.
25,857. SAUSAGE-SLICING MACHINE, W. A. van Berkel, Liverpool.
25,858. VALVES, J. S., T. A., and E. R. Walker, Liverpool.
25,859. FLOATING SEA ANCHORS, A. T. Rouse, Liverpool.
25,860. IRONING MACHINES, C. L. and I. Braithwaite, and E. O'Brien, Manchester.
25,861. DOUBLING FRAMES, Brooks and Doxey, Limited, and T. Bowker, Manchester.
25,862. DRIVE CHAINS, A. Appleby and E. A. Jeffreys, Birmingham.
25,863. RADIATING AXLES, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktien Gesellschaft, Germany.*)
25,864. GUN MOUNTINGS, A. T. Dawson and J. Horne, London.
25,865. STOMACHER, B. Goldmann, London.
25,866. GAS WASHER J. E. Dowson, London.
25,867. BOTTLE-CLEANING APPARATUS, W. Mauerhöfer, London,
25,868. CASES for HOLDING NEEDLES, E. Sattinger, London.
25,869. COVER for TRAMS and WAGONETTES, J. E. Clift, London.
25,870. TOBACCO PIPES, H. Lintoll and H. T. Tallack, London.
25,871. FABRICS for ORNAMENTAL PURPOSES, A. Briggs, London.
25,872. ENVELOPE, J. Gordon, London.
25,873. MUDGUARDS, J. D. Michell and F. Albone, London.
25,874. BOTTLE STOPPERS, S. H. G. and W. E. Higgs, London.
25,875. EXTRACTION of METALS, G. Dillberg, London.
25,876. REPAIRING DRAIN PIPES, &c., G. F. Restall, London.
25,877. EXPLOSION ENGINE IGNITERS, A. J. Boult.—(*Société Nouvelle des Etablissements Decauville Aîné, France.*)
25,878. JOINT for BALL and SOCKETS, E. D. Burkitt, London.
25,879. No application to this number.
25,880. MOTION-TRANSMITTING COUPLINGS, J. Marshall, London.
25,881. TREATING COTTON, F. Gros and P. Bourcart, London.
25,882. TOYS, R. A. Thompson and W. J. Freeman, London.
25,883. TOYS, R. A. Thompson and W. J. Freeman, London.
25,884. TOY GUN, R. A. Thompson and W. J. Freeman, London.
25,885. ACETYLENE LAMPS, S. Hallows and A. Tucker, London.

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25,886. BUFFERS for RAILWAY WAGONS, F. Ferris, Gloucester.
25,887. GRINDSTONES, J. Ford and J. Brightman, Rotherham, Yorks.
25,888. CASH REGISTER, A. W. Whieldon and N. E G. Little, Brierley Hill.
25,889. SECURING MOTTIES to CORVES, R. Wilkinson and H. Howcroft, Leeds.
25,890. CHECKING PICKERS in LOOMS, J. Pickthall, Burnley.
25,891. COVERS for CINDER-SIFTING SHOVELS, T. Brindle and J. R. Ellison, Chorley, Lancs.
25,892. RESILIENT WHEEL TIRE, S. Greenwood, Liverpool.
25,893. DRIVING GEAR for BICYCLES, S. Greenwood, Liverpool.
25,894. MEANS for PACKING TAPE in BUNDLES, Rylands and Sons, Limited, and A. H. Riddle, Manchester.
25,895. ELECTRIC SWITCHES, P. G. Ebbutt and Veritys, Limited, Birmingham.
25,896. LAMP SOCKETS, P. G. Ebbutt and Veritys, Limited, Birmingham.
25,897. FORGED BAR IRON, C. J. McIntyre, Barrow-in-Furness.
25,898. APPARATUS for REARING CHICKENS, E. A. Nichols, Birmingham.
25,899. FASTENERS of SWEEPING BRUSHES, C. B. Simpson, Halifax.
25,900. SPINNING FRAMES, E. Harwood, Halifax.
25,901. GOLF CLUBS, G. Lewis, Manchester.
25,902. SAMPLING LIQUIDS, A. R. James and W. Skett, Wolverhampton.
25,903. PENCIL, T. J. Woodward and W. H. Treges, West Bromwich, Staffs.
25,904. SHEARS, J. Webster and W. H. Vickery, Sheffield.
25,905. TROLLEY BRAKE, W. and J. Cowlishaw, Derby.
25,906. PLUMMER BLOCKS for SHAFTS, J. Evans, Birmingham.
25,907. BICYCLE STANDS, W. A. Horn, Coventry.
25,908. KNITTING MACHINES, H. A. Bettney and C. W. Hammersley, Nottingham.
25,909. PREPAYMENT METERS, L. H. Armour, Gateshead.
25,910. CAPSTAN, P. M. Baxter and W. Scott, Glasgow.
25,911. LIFE-SAVING APPLIANCES, J. James, Liverpool.
25,912. PENHOLDERS, G. J. Morgan, Bradford.
25,913. LIGHTING APPARATUS, W. F. Akerman and A. Normanton, Manchester.
25,914. SPRING TIRE, J. Cochran and C. Watkin, Armagh.
25,915. HOOK for WHIP SHAFTS, A. J. and R. H. Jackson, Northwich, Cheshire.
25,916. STOVES, T. L. Fyffe, Dundee.
25,917. ACETYLENE GAS, D. C. Beggs and W. Fielding, Ballyclare, County Antrim.
25,918. PLOUGHS, A. Damene, London.
25,919. MOTORS, H. Bremer, London.
25,920. STOVES, E. Berth, London.
25,921. MOUNTS for PICTURES, T. H. Radford, Aston Manor.
25,922. "L.B.S." SUNRAY BURNER, G. M. Lander, Glasgow.

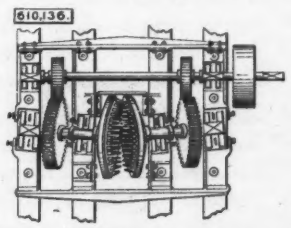
SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

610,136. COAL CRUSHER, *T. R. Griffith, Pittston, Pa.*—*Filed December 1st*, 1896.

Claim.—In a crushing machine of the character described, the combination with a pair of shafts provided with toothed crusher discs, journal boxes for said shafts, journal-supporting plates, means for

610,136.

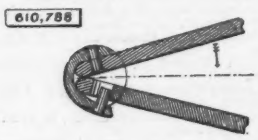


adjusting the journal boxes with respect to said plates, sole plates supporting the journal-supporting plates, and mechanism for adjusting the relations of said sole plates and journal-supporting plates, substantially as specified.

610,788. CARRIAGE SPRING, *S. R. Bailey, Amesbury, Mass.*—*Filed April 7th*, 1898.

Claim.—The herein-described carriage spring consisting of two members, one of which is provided with recesses or perforations at its opposite ends and the other member provided with socket pieces which freely support the ends of the opposite member, and

610,788

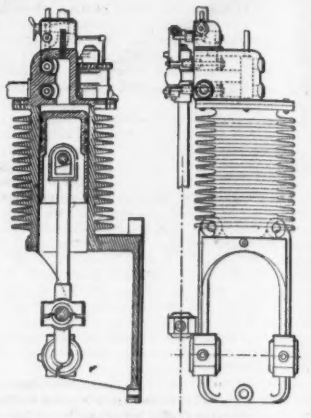


a projection on the interior lower portion of each socket piece, said projections being adapted to enter the recesses or perforations in the aforesaid spring member, substantially as and for the purpose set forth.

610,869. GAS MOTOR, *L. V. Pratis and P. Marengo, Turin, Italy.*—*Filed July 15th*, 1897.

Claim.—(1) The method of generating motive power which consists in subjecting a mixture of non-carburetted hydrogen with several times the proportion of air required for the formation of water, to wit with a volume of air from seventeen to twenty times that of the hydrogen, to a compression of not less than seven atmospheres, and igniting the so-compressed mixture, thereby producing a non-luminous nearly instantaneous combustion without fulmination, substantially as described. (2) In an explosive gas engine, in combination (with a gas engine cylinder uncooled by a jacket of water, and a piston working in said cylinder a source of non-carburetted hydrogen, means for admitting hydrogen from said source into said cylinder,

610,869

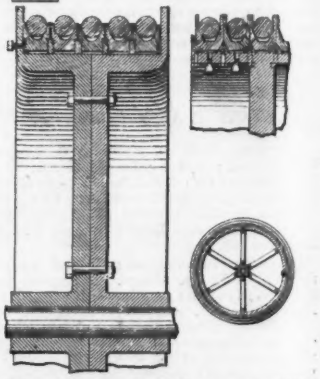


along with several times the proportion of air required for the formation of water, to wit a volume of air from seventeen to twenty times that of the hydrogen, means for compressing said mixture in said cylinder to a pressure of not less than seven atmospheres, means for igniting said mixture at the inner end of said piston's stroke, and means for retaining the burned gases in said cylinder during the forward stroke of said piston and for then discharging the same in an expanded condition, substantially as described. (3) In an explosive engine, in combination with an engine cylinder, a motor piston movable therein, admission valves comprising a hit-or-miss regulator valve and a valve with holes for air and combustible gas respectively arranged to regulate both holes in the same sense by one movement of said valve, and an exhaust valve, substantially as described.

610,912. ROPE-DRIVING MACHINERY, *T. S. Miller, South Orange, N.J.*—*Filed October 8th*, 1897.

Claim.—(1) In combination, a pulley and a rope embracing the same in power-transmitting relationship, the said pulley containing a plurality of grooved peripheral rings adapted to move on the surface of the pulley, and an interposed ring adapted to move horizontally but not circumferentially on the pulley and means whereby the frictional contact between the rings may be adjusted, whereby power is transmitted through the frictional contact between the grooved rings and interposed ring, but said frictional contact permits of slip between the said

610,912

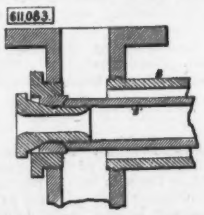


rings before the rope will slip in a groove, substantially as described. (2) In combination, a pulley and a rope embracing the same in power-transmitting relationship, the said pulley containing a plurality of grooved peripheral rings adapted to move on the surface of the pulley and an interposed ring stayed from circumferential movement, whereby power is transmitted through the frictional contact between the grooved ring and interposed ring, but said frictional contact permits of slip between the said rings before the rope will slip in a groove, substantially as described.

611,083. STEAM BOILER, *J. S. D. Shanks and R. Kelly, jun., Belfast, Ireland.*—*Filed March 26th*, 1898.

Claim.—(1) The combination, with a header-plate, of an external tubular plug secured in a hole in the said plate, a tube B^1 having a conical end, an internal tubular plug having a conical portion and screwed into the tube B^1, and a metallic packing ring fitting inside the said external plug and bearing against the conical portions of the said tube and internal plug, said conical portions being inclined in opposite directions, substantially as described and shown. (2) The combination, with a hollow header having two tube

611,083



plates, of an outer tube B secured into one of the said plates, an external tubular plug secured in a hole in the other said plate, which hole is large enough for the tube B to pass through, a tube B^1 arranged inside the tube B and having a conical end, an internal tubular plug having a conical portion and screwed into the tube B^1, and a metallic packing ring fitting inside the said external plug and bearing against the conical portions of the said tube and internal plug, substantially as described and shown.

THE WORKS OF THE ILLINOIS STEEL COMPANY, U.S.A.

THE Illinois Steel Company, owning and operating five separate plants, is one of the largest steel manufacturing companies in the United States, and is one of the most progressive in keeping up its equipment with modern and improved processes and machinery. The company has an authorised capital of £10,000,000, of which £3,730,000 has been issued. The report of the company for the year 1897 showed that the various works had produced during that year an aggregate of nearly 1,200,000 tons of pig iron and spiegeleisen, and 1,000,000 tons of finished product. It shipped its products to every part of the United States, to the bordering countries of Canada and Mexico, and also to Europe, Africa, Australia, South America, Siberia, Japan, China, and Korea. The following is a summary of the balance-sheet for that year :—

	£
Assets :	
Plants	3,984,200
Other investments...	1,403,800
Materials on hand, accounts, &c.	1,755,000
Total	7,143,000
Liabilities :	£
Stock and bonds	6,387,200
Bills and accounts	723,100
Reserve funds...	28,500
Total	7,138,800
Balance :	£
Surplus	4,200

The president of the company is Mr. John W. Gates; the vice-presidents are Mr. Charles H. Foote and Mr. W. Palmer; the secretary is Mr. William A. Green. Since this article was written, the company has effected a consolidation of several interests under the name of the Federal Steel Company. This great combination includes steel manufacturing, iron mining and railway, and other enterprises. Particulars of these allied interests were given in THE ENGINEER, of October 21st, 1898.

The Illinois Steel Company was formed in May, 1889, by the consolidation of the North Chicago Rolling Mill Company, the Union Steel Company, and the Joliet Steel Company. This consolidation brought under the control of the new company five separate plants, as follows :—(1) The works at North Chicago, established in 1857; (2) the works at Milwaukee, established in 1868; (3) the works at South Chicago, established in 1879. All these had been owned by the North Chicago Rolling Mill Company; (4) the works of the Union Steel Company, at Chicago, established in 1863; (5) the works of the Joliet Steel Company, at Joliet, established in 1870. These several works occupy about 700 acres of land, and comprise seventeen blast furnaces, four Bessemer steel plants, a large open-hearth steel plant, two modern rail mills, billet mills, plate mills, a slabbing mill, a twin rod mill, bolt and spike mills, and mills for fish-plates, joists, shapes, and merchant bars. There is also a plant for the manufacture of steel bridges and structural work, and another plant manufacturing cement from furnace slag. The works have seventeen miles of narrow-gauge railway, operated by thirty-two locomotives.

The company also owns coal mines, coke ovens, iron ore properties, and limestone quarries in different parts of the country. It also owns a controlling interest in the Chicago, Lake Shore, and Eastern Railway, which has extensive yards and effects connection with a number of the railways centreing at Chicago, thus affording means of direct communication by rail with all the different plants. This railway has in all 124 miles of main line and sidings, and operates about 370 miles. Its equipment includes fifty-seven locomotives and 3127 cars, a large number of which are employed in bringing coal, coke, limestone, &c., to the steel works. In the transportation system controlled by the company an interesting feature is the carriage by water of raw materials and products between the works at Milwaukee and South Chicago, a distance of about 90 miles. As both plants are on the shore of Lake Michigan, it was decided to get the benefit of the low rates for water carriage, and a contract was made with the Wisconsin and Michigan Ferry Company, by which the loaded railway cars are transported on large transfer boats fitted with rails and hauled by tug boats.

All the works are conveniently situated for obtaining raw material. The port of Two Harbours, on Lake Superior, from which the ores of the Mesabi iron range are shipped, is 1020 miles distant from Chicago by water. The Vermillion range is 690 miles distant by rail, while from the port of Escanaba, on Lake Michigan—490 miles by water—are shipped the ores from the Gogebic, Menominee, and Marquette ranges, which are 300 to 400 miles distant by rail. Thus ores of various grades can readily be delivered during the winter, if desired, when the season of navigation is closed. Coal for fuel and for making gas is hauled by rail from the coal mines of Illinois and Indiana, while oil is obtained from the Indiana oil fields. Coke is brought by rail from the Connellsville district of Pennsylvania, and the Pocahontas district of West Virginia, a distance of 500 to 625 miles. Limestone is brought by rail from the company's quarries at Loganport, Bloomington, and Bedford, about 175 miles distant.

Having now briefly described the property and plants of the company, its business and its resources, we shall proceed to describe more in detail the largest plant, that at South Chicago, usually designated as the "South Works."

These works, as already noted, were established in 1879 by the North Chicago Rolling Mill Company, which already had iron and steel works on the north side of Chicago and in Milwaukee. Four blast furnaces were blown in during 1880, and a Bessemer steel mill and rail-rolling mill were added in 1882. In 1889 the consolidation took place, and the Illinois Steel Company was formed, and since then the plant has been greatly enlarged and improved.

The works are situated on the western shore of Lake Michigan, near its southern extremity, and at the mouth of the Calumet River, about 12 miles south from the centre of the city of Chicago. They cover an area of about 260 acres, and have about 36 miles of railway of 4ft. 8½in. gauge, and 6½ miles of 3ft. gauge. The standard gauge lines are operated by the Chicago, Lake Shore, and Eastern Railway. The site has a frontage of 5200ft. on the lake, and 2500ft. on the river, with a dock on each side for the accommodation of shipping. The North Dock, opening from the lake, is 2900ft. long and 200ft. wide, and is protected against heavy seas by a narrow entrance. The South Dock, opening from the Calumet River, is 1000ft. long and 96ft. wide. On one side of the North Dock the company's manufactured products are loaded on the ships, while on the other side are the ore yards for blast furnaces Nos. 5 to 8, having a storage capacity of 700,000 tons. The South Dock is bordered by ore yards having a storage capacity of 400,000 tons, which stock is used for furnaces Nos. 1 to 4. Three large or four small vessels can be unloaded at once, while another is taking in coal, and still another is unloading timber. The docks have a depth of water sufficient for vessels of 18ft. draught. Not only can ore be delivered by four ships at once, but four other ships can at the same time be loaded with finished product in two men has unloaded 1600 tons in the morning and 1750 tons in the afternoon. This makes 3350 tons in eleven hours, or 7·25 tons per man per hour. The following are examples of records of quick work :—

	North Dock.	North Dock.	South Dock.	South Dock.
Cargo, tons	4000	2639	3350	2750
Men, including signal boys	158	81	42	95
Hoists	12	9	—	7
Time, hours...	8¼	6¼	11	6¼
Tons per hour	471	422	304·6	435
Tons per man per hour ...	3	5·2	7·25	4·6

The hoisting booms at the South Dock are of inverted V shape, with the legs pivoted on the floor of the dock, while the apex carries a sheave. The hauling rope is led over the sheave to a gallows frame, whose legs are in front of the boom, while the end of the boom projects beyond the cap of the frame. The ore buckets are cylindrical, 30in. in diameter and 24in. high, holding 850 lb. of ore. The bail is attached below the centre of gravity, and in hoisting the bucket is locked to the bail. The loaded bucket in the hold of the vessel is attached to a pulley suspended from the overhanging end of the boom, and a signal is given to the engineman on the dock. As the bucket is hoisted the boom is simultaneously raised to a vertical position, and the bucket swings in between

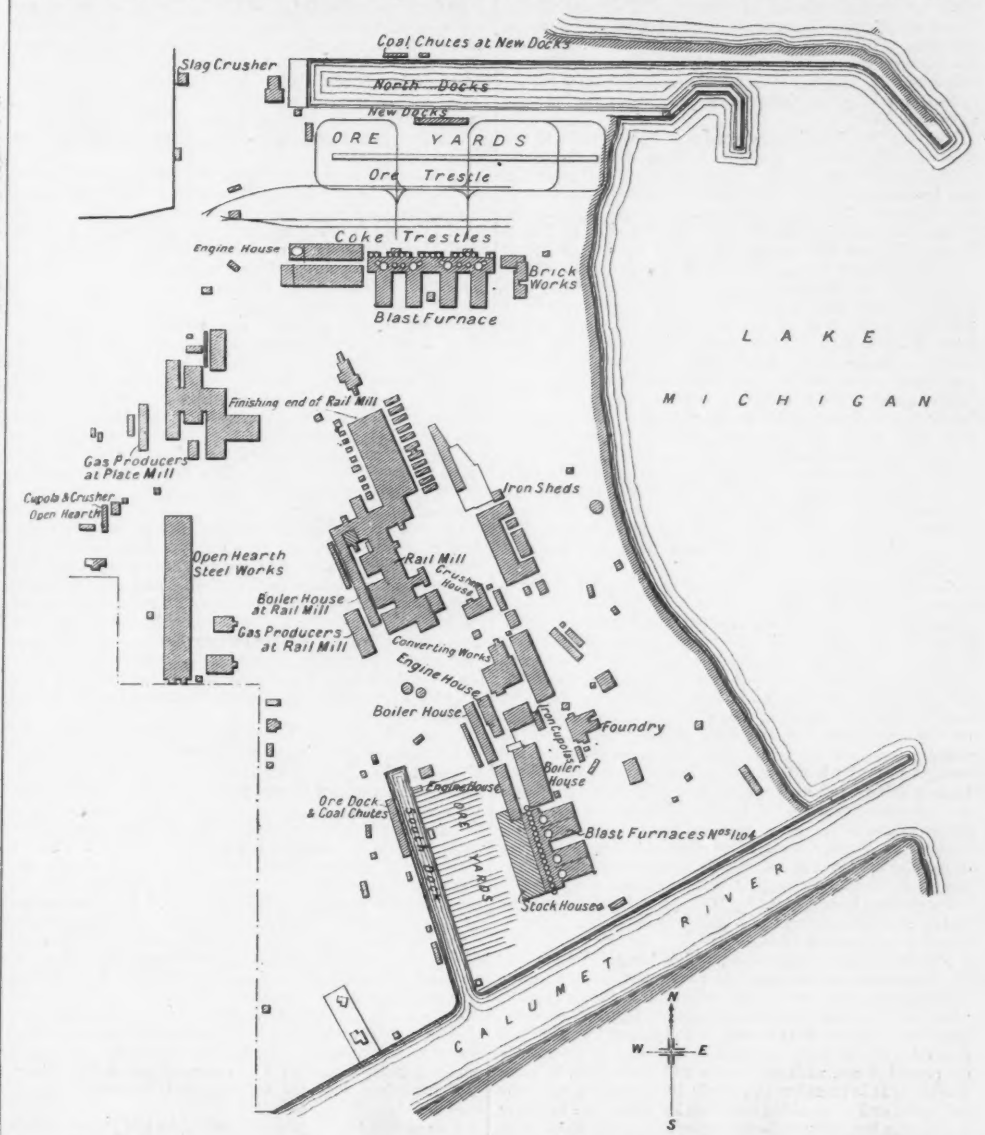


Fig. 1 Plan of the South Works of the Illinois Steel Company, U.S.A.

FIG. 1—PLAN OF THE ILLINOIS STEEL COMPANY'S SOUTH WORKS, U.S.A.

the shape of rails, billets, rods, wire, tin-plate bars, structural shapes, barrel hoops, nuts and bolts, pig iron, cement, &c.

During the eight months' season of navigation of 1897, there were 1,629,865 tons of ore received at these docks. As the cargoes are lighter during the winter months, and as several of the older and smaller vessels are still in service, the average cargo is about 3000 tons. The large modern steamers often bring 4000 to 5000 tons, and one vessel in 1897 brought a cargo of 5575 tons. There is at present a tendency to increase the cargoes, and when the lake harbours and the shallower parts of the channels between the lakes are deepened to provide for the intended draught of 21ft., it is expected that cargoes of 6000 tons will be carried. There is, of course, great economy in bringing very large cargoes per vessel, and this is one reason of the steady increase in size of the ore-carrying vessels on the great lakes.

At the North Dock the ore is handled by sixteen cantilever hoisting and conveying machines of the Brown type, handling scoop-shaped buckets of one ton capacity. At the South Dock, there is a row of fifty-three swinging booms, by which buckets are raised from the hold of the ship and dumped into iron push cars running on trestles over the ore yards. At this latter dock a gang of forty-

the legs of the boom, where it is caught by two men standing on a platform 20ft. above the ground. One of them releases the latch, and the bucket automatically dumps its load into a car holding about two tons. The bucket is then swung out and lowered, the boom swinging down at the same time, and another loaded bucket is attached. When the car is filled men push it along on the elevated tracks to any desired part of the yard, and then dump its load sideways to the ground below. In operation the equipment for each boom, or for each hatchway, consists of four buckets, two cars, or wagons, seven men shovelling in the hold, two men to dump the buckets, and four men to push and dump the car. If the ore is to be shipped away by rail it can be dumped from the bucket through a chute in the platform to a railway car standing underneath.

About 2,000,000 tons of ore are received annually at the two docks. It is unloaded here not only for the South Works, but also for the Joliet Works, and the Union Works, the ore for these latter two works being delivered directly from the vessels into the railway cars on the dock, as above noted.

The work at the ore docks goes on night and day, the work of unloading commencing as soon as a vessel arrives. It takes about six to twelve hours to unload a

vessel, the ore being taken out at the rate of about 40 tons per hatch per hour, or an aggregate of 200 to 530 tons per hour. Some of the steamers are of ordinary construction, resembling ocean cargo steamers, but usually having the engines well aft. There are also "whaleback" steamers, with rows of hatches across the deck, and having the engine at the extreme stern. Many of the steamers tow barges as long as themselves, these being either steel hulls of ordinary construction or whaleback barges.

Fig. 1 is a general plan of the works. There are eight blast furnaces, arranged in groups of four each. They have a combined capacity of 960,000 tons of iron per year, with a minimum fuel consumption of 1500 lb. of coke per ton of iron, and the furnace yield of ores from 55 to 62 per cent. Furnaces Nos. 1 to 4 were built in 1880-81, and are 75ft. high, with bosh diameters of 17½ft. to 19½ft. For each furnace there are four Whitwell-Foote hot-blast brick stoves, 21ft. diameter and 67ft. high, the flues from all of which lead to a single stack or chimney. The waste gas from the furnaces which is not used in the stoves serves as fuel for forty horizontal tubular boilers, 6ft. diameter and 20ft. long, supplying steam at 100 lb. pressure for the blowing engines, and also for the engines in the Bessemer department.

There are ten blowing engines, two to each furnace, with two extra engines in reserve. They are of the Cuyahoga Engine Company's vertical type, with steam cylinders 36in. by 54in., and air cylinders 84in. by 54in., the latter being on top. Some of them have the Corliss valve gear. They are to be compounded, two steam cylinders taking the place of the present single cylinder to each engine.

Furnace No. 1 ordinarily produces spiegel iron at the rate of 7000 tons per month. A stock house, 368ft. by 100ft., shelters the daily supply of coke, and hoists in two brick towers 100ft. high raise the stock to the tops of the furnaces. The casting-houses are of brick, and each furnace has a casting bed 62ft. by 150ft. The output of each furnace is about 300 tons of pig iron in twenty-four hours.

Blast furnaces Nos. 5 to 8 are shown in Fig. 2. They were built in 1890, and are 85ft. high, with bosh diameters of 19ft. 6in. to 20ft. 9in. Each has a capacity of 375 tons of pig iron in twenty-four hours. There are four Massick and Crooke hot-blast stoves to each furnace, these being 74ft. high and 22ft. diameter, and each stove has its own stack or chimney for the waste gases. The furnace gas also serves as fuel for forty-eight horizontal tubular boilers, 6ft. diameter and 20ft. long. These supply steam for ten vertical condensing blowing engines of the Porter-Allen type, made by the Southwark Foundry and Machine Company. The steam cylinders are 40in. by 60in., and the air cylinders 84in. by 60in., the latter having positive-motion gridiron valves in the cylinder heads. It is proposed to compound some of the engines in order to secure increased economy.

Limestone, coke, and the ore received by rail are dumped in stock piles from railway cars of 30 tons capacity, there being about 6500ft. of standard-gauge track on trestles about 12ft. high, approached by an incline. These trestles are parallel to the line of the furnaces, and there is but a short distance for transportation from the stock piles to the charging hoists. The coke is dumped into bins, from which the charging car or "buggy" is loaded, the coke passing over a screen which takes out the dust. The ore is loaded into the charging cars by hand, or by a steam excavator, whose bucket holds a full load for one car. The charging cars are assembled and hauled to the furnaces by a narrow-gauge locomotive. Each furnace has a double platform vertical hoist tower of steel frame construction, fitted with cages, and operated by a Crane Company's hoisting engine, with cylinders 12in. by 12in. Each furnace has also a brick casting house, 63ft. by 164ft., furnished with sand beds and sand runners for pouring the iron into ladles or into the pig-casting beds.

The dust from the furnaces, which is carried over into the flues by the waste gases, is prevented from entering and clogging the stoves by means of a dust chamber, which is a balloon-like enlargement of the flue, in which the dust collects. This is seen at the left of Fig. 3, which is a view of the base of furnace No. 5. As the dust is composed of ore, with some coke and limestone, it is not wasted. It is mixed with a little lime to give cohesive strength, and is moulded into bricks which are baked in a chamber heated by exhaust steam and waste gases from a boiler. These bricks are then again charged into the furnaces, thus avoiding a considerable loss by waste.

The iron is ordinarily run from the furnaces into 12-ton ladles, which are hauled on cars to the Bessemer or open-hearth steel plants. The Sunday iron is cast into pigs, which are used at the steel plants or shipped away. The slag is run from the furnaces into slag cars of the Weimer pattern, which are emptied into long beds, the slag forming layers 2in. to 3in. thick. When a sufficient quantity has accumulated, it is excavated and loaded into railway cars of 30 tons capacity by a steam excavator, which can load ten cars per hour. This broken slag is used for railway ballast, road metal and concrete. It has also been used for the manufacture of building brick. There is also at the works a special plant for making mineral wool or slag wool, by spraying a jet of molten slag with steam jets. This material is extensively used for the insulation of heat and sound, and in covering steam pipes, filling floor spaces, &c.

The Bessemer steel plant was put in operation in 1882, and has now a capacity of 2200 to 2600 tons of ingots in 24 hours. In 1890 the form of the converters was changed, a concentric nose being adopted in place of the old hood-shaped top with excentric nose. The three new converters are 14 tons capacity instead of 10 tons. There are four blowing engines in the Bessemer mill. Two of these are vertical engines, similar to those at the blast furnaces, but delivering air at 20 lb. to 25 lb. pressure. They will probably be converted into compound condensing engines. The other two are horizontal engines of an old-fashioned type.

The general arrangement of the converters, hot metal delivery track, casting pit, and cranes, is in accordance with the design of Mr. R. Forsyth, and arrangements are being made for removing the converters weekly, or whenever desired, as originally contemplated in Mr. Forsyth's plans. The converters have Mr. A. Holley's system of removable shells, the shells and bottoms being handled rapidly by hydraulic lifts under the converters. Increased speed in changing the bottoms is now obtained by the use of a special form of car or truck. Each converter has a shell independent of its trunnion ring, and when the lining is thin or out of shape the shell can be released and withdrawn, a new one being at once pushed in and secured in position. This enables the mill to maintain a large and regular rate of production. The molten iron is brought from the blast furnaces in 12-ton ladles, as already noted, and is charged into two horizontal cylindrical mixers, Figs. 4 and 5, each of which holds 150 tons of iron. By thus mixing the iron from different casts from the various furnaces an iron of great uniformity in chemical composition and in temperature can be obtained for the converters. The ladles are raised to the charging floor by a hydraulic lift, which revolves through an angle of 90 degrees during the ascent, thus bringing the spout of the ladle into position for pouring. The tilting up and back of the ladle is effected by power applied through an adjustable socket, which is thrown into gear with the mechanism of the ladle, and then disengaged. The empty ladle is hauled across the floor on a cable railway, and is let down by another hydraulic lift, which, while descending, is turned into position to run the ladle out on the surface track.

Each mixer is supported on four rollers, and has a circular rack on one side. By means of a rack attached to the plunger of a hydraulic cylinder, the mixer can be revolved so as to discharge its contents through a spout into a ladle standing on weighing scales. The ladle is then run on to an elevated track in front of the converters, and is emptied and returned to position by power. There are three iron cupolas adjoining the mixing building, in which pig iron is melted and delivered to the mixers when desired. Two are 10ft. in diameter and the other is 11ft. diameter, and they have an aggregate capacity of 5500 tons per week. Should the metal in the mixers cool from long delay, its temperature can be raised by oil burners, which spray a flame over the iron. Spiegel iron for re-carburising is obtained by melting the pig in four cupolas, or is taken from a mixer supplied with hot metal from a blast furnace. The latter method is the cheaper, and gives greater uniformity in the chemical composition.

After the re-carburising process in the converter the steel is poured into a receiving ladle, and thence into the casting ladle, the double pouring ensuring a perfect mixture and uniformity in the steel. The casting pit is circular, and has about 250 degrees available for ingot casting, the remainder being for handling and cleaning the ladles. The pit can hold three heats, or twenty-one ingots, which capacity is ample. Another casting pit in the rear of the ladle-repair shop is used for soft Bessemer steel ingots used in making some of the poorer grades of plates.

As soon as the iron has been run into the ladles at the blast furnaces the foreman of the furnace plant telephones to the clerk at the mixer, giving him the estimated percentage of silicon and sulphur. These figures are used for calculating the composition of the metal in the mixer, which calculation is repeated as soon as the true analysis is received from the laboratory. Under this system the variation between the calculated and actual analyses may be kept within 0·1 per cent. of silicon and 0·05 per cent. of sulphur. The calculation of the composition of the metal in the mixer is performed by a chart and decimal scale, on the principle of proportional triangles. This is found to be as satisfactory as a slide rule in rapidity and ease of working. When the iron from the mixer enters the Bessemer mill, the steel blower is given a ticket showing the weight and composition of the metal, and is guided by this in controlling the blowing operation. The laboratory at the converting works is independent of the main chemical laboratory, and furnishes analyses to the steel blowers and the metallurgist.

One or two test ingots—according to the requirements of the specifications—are taken from each heat, and these are 2½in. square and 6in. long. One is for chemical analysis and the other for physical test. The test piece is ¾in. square and 20in. long, and when cold must be bent to a right angle by blows from a hammer. One piece, about 1in. square and 3in. long, is sent to the chemical laboratory, where drillings are taken and the chemical analysis made for that heat.

The iron is poured into open moulds standing on cast iron stools forming ingots, which are 16in. square and weigh from 4500 lb. to 5000 lb. The moulds are stripped from the ingots as soon as the latter have solidified sufficiently to bear handling, and the stripping crane then places them on iron cars on a narrow-gauge track. A locomotive hauls them to the mould yard, where they are left to cool. The ingots while still white hot are taken to the rail mill, being kept in a vertical position all the time.

In the original plant each mould or ingot was handled separately by 5-ton Holley hydraulic cranes, but these gave way to three Wellman steam and hydraulic jib cranes, lifting two moulds or ingots. The latter are in turn to be replaced by 15-ton cranes having three sets of tongs, so that the number of lifts per heat, for the same weight of product, will be six instead of eighteen. The improved facilities for handling will effect an increase in the output, and avoid the method sometimes practised of casting into moulds mounted on cars or trucks.

The capacity of the converting work is about 625,000 tons of steel ingots per year, the output being about 2550 tons of ingots per twenty-four hours. During the month of December, 1897, the output was 54,176 tons in 49½ turns of twelve hours. For the year 1897 it was 520,245 tons of ingots in 536 turns.

(To be continued.)

THAMES AND SEVERN CANAL.

IN our issue of May 8th, 1896, we gave a plan and section of the Thames and Severn Canal, with some photographs taken in various places along the line of the canal, showing its neglected and decayed condition. We are now glad to be able to state that the work of restoration commenced in the early part of 1896 by the Thames and Severn Canal Trust is completed, and it only remains for the canal to fill with water for traffic to re-commence throughout.

The Thames and Severn Canal commences by a junction with the Stroudwater Navigation at Wallbridge, Stroud, and passing Brimscombe and Chalford, rises 241ft. to the summit level at Daneway by twenty-eight locks. The first 4¼ miles of the canal from Wallbridge to Bell Lock, Chalford, have never been closed for traffic, but from above Chalford to Inglesham, the junction with the Thames, there has been no through traffic for some years, and this portion has been the scene of the restoration works.

The summit level of the canal extends from Daneway to Siddington, a distance of 8 miles 8½ chains, and from Siddington there is a short branch to Cirencester, 1 mile 2 furlongs 5 chains long, and on the same level, making a total distance of 9 miles 3 furlongs 3½ chains. This summit level, passing as it does through very bad ground, has always been in the past history of the canal its weakest point, on account of the constant leakages which occur, and it is doubtful whether there is any portion of canal in England more troublesome to keep water-tight than this has been. In Mr. Robert Whitworth's report of December 22nd, 1782, he states the following:—"Unfortunately the level leads over some bad rocky ground, which cannot be avoided for several miles together, that is worse than I have ever seen any canal cut through for such a continued length, yet there cannot be the least doubt but that by time and money it may be made moderately water-tight."

Unlike the summit levels of most other canals, that of the Thames and Severn is not provided with reservoirs for storing water, but is solely dependent for its supply on the pumping engine at Thames Head, and a feeder from the river Churn entering the canal at Cirencester. This feeder can only be used free of charge on Sundays, owing to the prior rights of the millers on the Churn.

The pumping engine at Thames Head, situated 4½ miles from the end of the summit at Daneway, was erected in 1852, and was constructed by Messrs. Thomas and Co., of Charlestown Foundry, Cornwall. It is a beam engine, and pumps from a well 63ft. deep, delivering 3,000,000 gallons in twenty-four hours.

Every effort will be made to maintain the water in the summit level at a height of 3½ft. above the lock sills, and not to allow it to fall below 3ft.—that is, to use only for locking purposes the 6in. between 3ft. and 3½ft. Twenty-five chains from Daneway Bridge commences Sapperton Tunnel, by which the canal is led through the Cotswold Hills. This tunnel is 3808 yards long, of which 1436 yards are in rock, being the upper beds of the inferior oolite, and 2372 in brick arching. The width in the narrowest place is 11ft. 8in., and there is no towing path. Twenty-four shafts were sunk for use during its construction, the deepest of which is 234ft. from the bottom of the canal to the ground level of the hill above. From Siddington summit lock the canal descends by eleven locks a distance of 4¾ miles to Latton, where there is a junction with the North Wilts branch of the Wilts and Berks Canal from Swindon, giving communication thus eastwards from Swindon, to the Thames at Abingdon, and westwards from Swindon to the Kennet and Avon Canal at Semington.

From Latton to the junction of the canal with the Thames at Inglesham is a further distance of 8¾ miles, with a descent of five locks, the total fall from Siddington to the Thames being 130ft. 6in.

There are altogether on the canal fifty-seven bridges and forty-four locks. The dimensions of the locks are, between Wallbridge and Brimscombe, 68ft. by 16ft.; between Brimscombe and Chalford Chapel Lock, 70ft. by 12ft. 9in.; from this lock to Daneway, 75ft. by 12ft. 9in.; and between Siddington and South Cerney Bottom Lock, 75ft. by 13ft.; and from here to Inglesham, 97ft. by 13ft., with the exception of Latton Lock, which is 75ft. by 13ft.

The work of restoring the canal has been carried out under the direction of Mr. G. W. Keeling, M.I.C.E., Mr. E. J. Cullis, A.M.I.C.E., having been the executive engineer.

Since August 5th, 1898, Mr. W. J. Snape has had sole charge of the canal and works as manager and engineer. Mr. Snape holds the same appointments for the Stroudwater Navigation, and the joint office of both Navigations is at Wallbridge, Stroud.

The following are the principal places on the canal, with their distances from Stroud:—

Stroud to—	Miles.
Brimscombe	2½
St. Mary's	3½
Chalford Wharf	4
Valley Lock	4½
Bakers Mill Wharf	5½
Puck Mill	5¾
Whitehall	6¼
Daneway Wharf	7¼
Daneway end of Sapperton Tunnel	7½
Coates " "	9½
Thames Head Wharf	11¾
Thames Head Pumping Station	11¾
Siddington top lock, junction with Cirencester branch, 1¾ miles	15½
Siddington bottom lock	15½
South Cerney top lock	16¾
Wilmoreway	18¾
Cerney Wick	19½
Latton, junction with North Wilts Canal	20¼
Latton Wharf, Cricklade	21
Eisey	22
Marston	23½
Castle Eaton Bridge	24
Kempsford	25½
Dudgrove	28
Inglesham, junction with river Thames	28¾
Lechlade Wharf on river Thames	29½
River Severn to Thames	37¾

The through tolls fixed for all classes of goods passing over the canal are, from Stroud to Cirencester, 6d. per ton; and from Stroud to Inglesham, 1s. 2½d. per ton.

The restoration of the navigation of the river Thames from the junction with the Thames and Severn Canal at Inglesham to Oxford, a distance of 33 miles, is now on the point of completion by the Thames Conservancy.

THE BARRY DOCKS.

(Concluded from page 584).

THERE still remains something more to be said about the interesting excursion to Barry Dock. Reference to the plan, Fig. 1, will show that along the west side of Lady Windsor deep sea lock there is a graving dock, whilst at the north-east corner of Dock No. 1 other graving docks are shown; the former belong to the Barry Railway Company, the latter to the Barry Graving Dock and Engineering Company. The Barry Railway Company's graving dock is known as the Barry Commercial Graving Dock; it has the following dimensions:—The outer side bay, 346ft. in length; the inner, 327ft.; the length from the outer to the middle caisson is 366ft., and from the middle caisson to the end wall 363ft.; this is being extended to 483ft., which will give a total length of 869ft. The width at entrance is 60ft., at the top of dock 113½ft., at the bottom 100ft. The depth of water on the sill at high water ordinary spring tides is 26ft. 6in., and at high water ordinary neap tides 18ft. 3in. 937 vessels have used this graving dock. It can accommodate four vessels at once. The pumping machinery consists of seven centrifugal main pumps with a combined capacity of 260,000 gallons per minute and two small drain pumps capable of pumping together 12,000 gallons a minute, and the water can be pumped either into the dock or into the sea.

The Barry Graving Dock and Engineering Company's dock at the north-east of Dock No. 1 is a double dock with an entrance 60ft. wide, furnished with a wrought iron box caisson; a similar caisson divides it at the middle; the outer side bay is 314ft. long, the inner 318ft., the length between the caissons and between the middle caisson and the end wall is in both cases 355ft.; the total width of the floor is 100ft., and at the coping 113½ft. The depth of water on the sill is at high water ordinary spring tides 24ft. 6in., and at high water ordinary neap tides 16ft. 3in. Four ships can be accommodated at the same time in this graving dock, and up to May 2183 vessels had used it. If necessary the middle caisson can be removed, but this is rarely needed. The inner portion of this dock was also being extended to give a length of 405ft., or a total length of 778ft. This company is moreover constructing a new single dock, which is shown alongside of the double dock on the plan, Fig. 1. We give two illustrations—Figs. 40 and 41—which will give some idea of the operations connected with this work. The marl is 65ft. below the coping level at parts, and, as will be seen from Fig. 40, very heavy timbering is required in trenching for the side walls; this is owing to the fact that the site is that of an old timber pond cut. Fig. 41 indicates very clearly the system of construction followed. The walls are of masonry with foundations of cement concrete, with large stones embedded; the floor is of cement concrete, on a foundation of lime concrete with stones embedded, and where necessary stone filling is used in the way shown. The dimensions of this graving dock are—width of entrance 65ft., of floor 66ft., at coping 81ft., total length 623ft. Depth of water on sill at high water ordinary spring tides 27ft. 6in., at high water ordinary neap tides 19ft. 3in.

A pleasant and interesting feature of the visit to Barry was the trip round the docks in electric launches, passing round the old dock, then through the unfinished junction out into the new dock, thus enjoying the distinction of being passengers in the first craft to enter Dock No. 2. The appearance of the new dock from the launches was very fine, and not only could the excellent workmanship be investigated, but we were enabled to realise the extensive area of this great sheet of water. This trip was followed by an excellent luncheon given by the Barry Railway Company, and then by the visit to Barry Island and Whitmore Bay already referred to; at 3.40 the departure took place, and at 4 our kind hosts took leave of us at Cardiff and handed us over to the tender mercies of the Great Western Railway Company.

We may fittingly add to our remarks on the new works at Barry Dock the names of those who have been mainly concerned in bringing the works to a successful termination. The consulting engineer is Sir John Wolfe Barry; his resident, Mr. R. C. H. Davison, to whom we are indebted for illustrations, and most of our information on the subject. The Barry Company's engineer is Mr. James Bell, who, with the assistance of Captain Dawes, its dock master, directed the dredging for the Lady Windsor Lock, which necessitated the removal of 84,000 cubic yards, mostly of rocky marl, that had to be cut to 18ft. below low-level of ordinary spring tides. Then the contractors for the various works were as follows:—Sir John Jackson, the Barry Commercial Graving Dock and the locks and jetties of the deep sea lock; Messrs. Robert Stephenson and Co., the lock and dock gates; Sir W. G. Armstrong, Mitchell, and Co., the gate machinery, the hydraulic cranes, and capstans; Messrs. Brown, Lenox, and Co., the fender chains, buoys, and other chains; Messrs. Price and Wills, the island railway, and the dock railways and buildings; Messrs. E. C. and J. Keay and Messrs. John Lysaght supplied the trestle and girder work, the last-mentioned firm also furnished the pontoons; Messrs. Tannett Walker, and Co., the winding engines and sluice machinery of the lock, and the coal tips and hydraulic engines of the new dock. The late Mr. T. A. Walker was the contractor for the graving dock of the Barry Graving Dock and Engineering Company, and for the main dock and railways.

It may be noticed that all the machinery of the dock is worked by hydraulic pressure at 750 lb. per square inch, there are three installations, all shown on plan Fig. 1, but all the mains are connected and circuited. In all there are eight pairs of compound horizontal surface-condensing engines with steam cylinders 16in. and 28in. diameter by 24in. stroke, supplied with 80 lb. steam from twenty-three Lancashire boilers 28ft. long by 7ft. diameter. The pressure pumps are on the differential ram principle, the diameters being 4¾in. and 6¾in., the water storage is provided by twelve accumulators with rams 22in. internal diameter, loaded to maintain the pressure. There are seven miles each of 7in. hydraulic pressure mains, of 8in. hydraulic return mains, and of 5in. fresh-water mains. There are also for manipulating ships and wagons, discharging cargo, &c., forty-one movable hydraulic pedestal cranes, five fixed hydraulic cranes—one of them 50 tons. One steam floating crane, five steam travelling cranes, three hand travelling cranes, one hand fixed crane, 120 hydraulic capstans—four of 10 and twenty-seven of 5 tons; 252 bollards, 171 mooring rings, forty-five buoys, and various accessories. The docks, tips, sidings, entrances, works, workshops, and stations are all illuminated by electricity; the plant is housed near the north hydraulic engine house, from which the steam is supplied, and consists of eight engines of 970 indicated horse-power, driving six Crompton dynamos, two Patterson and Cooper's dynamos, three Brush and two Crompton alternators. There are 159 arc lamps, 2593 incandescent lights, fifteen transformers for lowering 2000-volt current to 110 volts, and a total length of thirty-five miles of electric mains. Messrs. J. Stone and Company's system of electric lighting is used in the passenger coaches. The Barry Railway is well-connected in every direction with other railways, and itself owns over thirty miles of railway, and forty-eight dock sidings, and ninety-three locomotives, ninety-six passenger carriages, twenty-four passenger vans, and 1186 goods and other wagons that are always being added to as required. There are engine sheds, fitting and workshops, where all repairs to locomotives and other machinery are done, whilst in the vicinity of Barry Dock Station new offices are being erected; the building is three storeys high, and covers an area of 2050 yards.

TABLE A.

	Gross tonnage.	Length, ft.	Beam, ft.	Draught, ft.	Time coaling.	Total load, tons.	Tons coaled per hour.	Tons in Bunkers.
S.S. Racine	1573	250	35·3	18	4½	2081	462	—
S.S. Haberton... ...	1443	247	35·3	15·6	4¼	1947	458	—
S.S. Ocean	1442	247	35·3	15·6	4⅓	1934	446	60
S.S. Activity	1091	225	31·8	16.2	4	1327	332	58
S.S. Harlring	1838	268·2	37·7	17	5½	2467	460	70
S.S. Nordboen... ...	2404	310	44	20·4	26½	4055	154	460

The trade at Barry Dock has shown a continual increase ever since the opening in July, 1889; in the following year the total imports amounted to 63,675 tons, the exports to 3,201,597 tons; the number of vessels was 1753, with a registered tonnage of 1,692,223, of which 1321 with a tonnage of 1,310,089 were steamers, and 432 with a tonnage of 382,184 were sailing vessels. In 1897 the total imports were 248,349 tons; exports, 5,859,255 tons; the number of steamers 2489, tonnage 2,844,862; sailing vessels 317, tonnage 322,449; total number of vessels 2856, with a registered tonnage of 3,167,311. Since the opening to end of 1897 the numbers are:—Total vessels, 18,687; tonnage, 19,594,964; total imports, 1,226,487; exports, 37,783,590 tons; exports and imports together, 39,010,077 tons. The imports include pitwood, timber, rails, silver sand, iron and iron ores, building materials, and general merchandise; the exports, principally coal and coke, a few rails, a small quantity of iron and iron ore, and a few thousand tons of general merchandise. This year the coal strike will have considerably interfered with the working of the dock, and the actual output will consequently be diminished; to what extent is a factor that will be regarded with interest by many people.

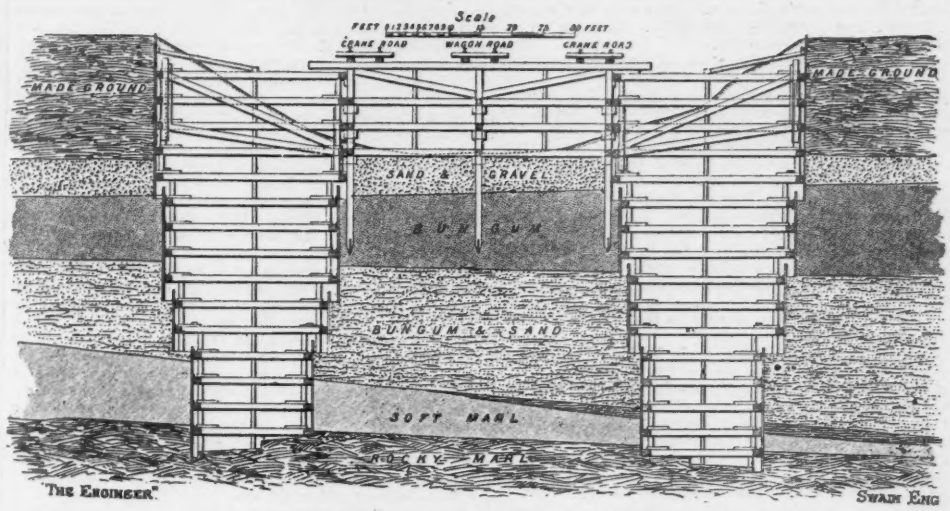


Fig. 40—TIMBERING FOR NEW DOCK EXCAVATION

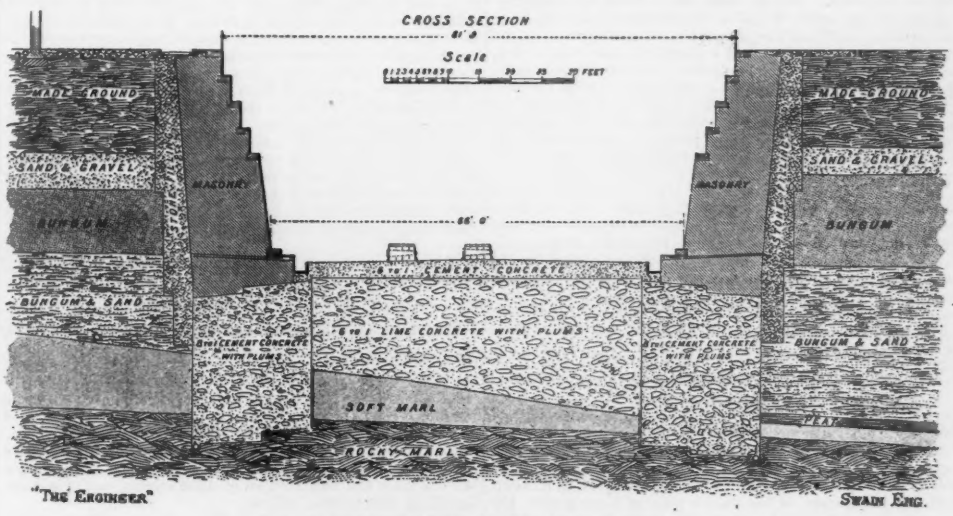


Fig. 41—CONSTRUCTION OF NEW SINGLE DOCK

A word or two may now be said about the coal tipping. The possible capacity of a tip is far greater than the actual tipping done by it, inasmuch as very many delays occur, and consequently about 300,000 to 350,000 tons may be taken as a fair estimate for the annual output of a tip, although judging from the performance during short periods of time, and calculating from that the annual output, a number ten times as great may be stated but would not be correct. The actual amount tipped in 1897 was 5,854,920 tons from 23 tips, or an average of 254,562 tons per tip.

Trimming in the vessel, changing vessels, waiting orders and cargoes, slack seasons, breakdowns, &c., are sources of delay, but we give in Table A, borrowed from Mr. Davison's paper, some examples of the despatch of vessels.

All except the last were self-trimmers, and in that case no less than 12½ hours were spent in shifting tips and getting in the bunker coal, although three tips were used. In the first two cases one, and in the second two, tips were used.

It is interesting to state that the population of the district is now about 30,000, although in 1884 it was not above 100. There are 5206 houses on the spot, and the number of men employed is 1708; moreover, there is an excellent service of trains, so that those preferring to live elsewhere find every facility offered them for their conveyance backwards and forwards.

KING'S COLLEGE, LONDON.—The David Salomons Scholarship for 1899 has been awarded by the Institution of Electrical Engineers to T. R. Renfree, student in the Siemens Engineering Laboratory of King's College.

MOTOR CARS IN PARIS.

The section devoted to mechanically-propelled vehicles in the Salon du Cycle et de l'Automobile, which was opened in the Galérie des Machines in Paris last week, was much larger than might have been expected in view of the fact that makers had shown all their latest types of motor cars at the Tuileries Exhibition in June. Since then a good deal of progress has certainly been made in the designing of mechanical vehicles, and the new systems of propelling mechanism exhibited at the Salon were decidedly interesting. In speaking of new systems, however, we do not mean to infer that any notable departure has been made from the various types of spirit engines already adapted to road vehicles. In most cases the new motors were designed on principles which had been tried in the early days of the motor car industry, and for some reason or another abandoned, and the others were simply copies of existing motors, modified in certain details to constitute "improvements." The most striking thing about the show was the desire of even the makers of the highest standing to find something better than their present types of engines. None of the firms are apparently entirely satisfied with their mechanisms, and there is a keen anxiety to hit upon new propelling devices that shall be far in advance of the motors now in use.

The Société des Automobiles Mors, for instance, exhibited vehicles fitted with two new types of engines. The system they usually employ is a motor with four cylinders coupled in pairs at an angle of about 90 deg. They build cars in the form of a dogcart, and the machinery is placed behind the rear axle. A lighter type of four-seated car was shown with a horizontal two-cylinder engine placed transversely in the fore part of the car, the two cylinders being as nearly as possible in the same axis. They are flanged for air cooling, and are also fitted with water jackets. This was the type first designed by M. Mors for the propulsion of road vehicles, and he apparently finds that for the lighter cars it gives better results than the four-cylinder engine. To a heavier type of car M. Mors had fitted a two-cylinder vertical motor of 8-horse power, which was also placed in front. The design and arrangement are very similar to that of the Daimler engine.

Another departure has been made by MM. Panhard et Levassor, who are beginning to cater for the needs of buyers who cannot afford to pay fancy prices for the highly-finished carriages turned out at the Avenue d'Ivry works. The little car they showed for carrying two persons was fitted with a 3-horse power single-cylinder horizontal motor. The cylinder is flanged, and also has a water jacket. As the motor is in the rear the tranmission gear is, of course, not the same as in the ordinary Panhard cars, but is more direct, and operates with less complicated gearing on to the countershafts. In the cars exhibited by the Société des Automobiles Peugeot there was no change beyond the substitution of electric ignition for the incandescent tube on two of the cars. M. Peugeot has been carrying out experiments for some time past in this direction, and has met with such success that he has decided upon adopting this method of firing for the future. Now that M. Peugeot is about to abandon the platinum tube there are only one or two firms at the most who continue to use it.

The well-known carriage builders, Belvallette Frères, showed for the first time a beautifully-finished carriage propelled by mechanism on the Bergmann system. The motor is a horizontal single-cylinder engine of 5-horse power. The piston operates a shaft carrying three pulleys for the various speeds, and each pulley has a loose leather belt connecting with the countershaft. A lever terminating in a jockey pulley comes down on one or other of the belts, and gives the desired tension for the running of the vehicle. The lever is operated from the seat and moves transversely over the range of three belts, and the pressure may be increased or diminished as required. The gas mixture is fired by magnetic-electric ignition, and it would be interesting to know whether the sparking is sufficient to ensure the regular running of the motor. As the carriage shown was the first one constructed, and had only recently been completed, the experiments have, no doubt, not been sufficiently conclusive to prove the efficiency of this system. The driving gear has been simplified as much as possible, and it is claimed that the carriage may be started from the driver's seat, though it is to be remarked that in no other vehicle for which similar claims have been made has the starting gear acted at all satisfactorily.

The light car shown by M. Th. Klaus is only new in the sense that it was exhibited for the first time. It has been worked upon for some years past, and has apparently now reached its definite form. It has two horizontal motors, one on each side of the car. The cylinders are cooled by air flanges and a water jacket, as is the case with most of the small motors recently introduced, but despite these precautions we have found that the motors get very hot after running a short time. The controlling of the inlet valves by means of a spindle on the steering lever working against a segment piece is very ingenious. The motor is stopped by merely raising the lever. To start the engine, a lever terminating in a ratchet working on a pinion is operated from the seat, but evidently this is found impracticable, for on the vehicle exhibited the lever had been suppressed.

Another new exhibit was that of the Compagnie des Automobiles Henriod, who have lately brought out a carriage in which the propelling mechanism is designed by M. C. E. Henriod. As in the case of the latest type of Mors motor, the two cylinders are placed transversely in the fore part of the carriage, and the pistons work on one shaft, carrying the fly-wheel, and terminating in three pinions which gear into bevel wheels on the countershaft for the various speeds and for reversing. The cylinders are flanged and have no water jacket, the idea being, apparently, that the draught set up by the fly-wheel will be sufficient to keep the engine cool. We have found, however, in practical running that there is a decided liability of the engine to get hot.

An interesting vehicle was that exhibited by the Société des Moteurs Gobron et Brillie, in which it is sought to secure a perfect balance and suppress the vibration by exploding the gas mixture between two pistons. There are two vertical cylinders, and consequently four pistons, the lower pair acting directly on the shaft, and the upper two by means of rods and bevel gearing. The motor, which developes 6-horse power, ran for seven consecutive hours on each day of the show, and the noise and vibration were certainly much less than we have noticed in any other mechanical vehicle. MM. Faugère, Ochin et Dangleterre, of Corbeil, are one of the newest firms to engage in the motor car industry, and they exhibited a couple of vehicles fitted with two-cylinder horizontal motors of 6-horse power. The crank shaft carries two fly-wheels, between which is the belt for the transmission. The whole of the mechanism is enclosed in a gear case, which may be easily removed by loosening three or four bolts. The engine is started from the seat by a lever, for which system the firm claims to have a patent. M. L. Fisson has abandoned the Benz motor he formerly employed for a two-cylinder vertical engine of his own design. The motor is placed in the fore part of the car and the power is transmitted by spur wheel gearing, which is entirely enclosed. The exhaust is conveyed into an unusually large "silencer" for suppressing the noise and odour.

The only steam carriage exhibited was the "motocar" constructed by Count Dalla-Décimas and several other gentlemen interested in the mechanical vehicle movement, but unfortunately their efforts do not appear to have been crowned with entire success. The generator at the rear of the car is ingenious. It is composed of a series of concentric tubes with spirals between them, to ensure the superheating of the steam by a longer circulation in the hot tubes. The heating surface is said to be 3½ square metres. There is a row of petroleum burners underneath a few inches from the ground, and it is difficult to believe that they would remain alight in wet and muddy weather, while even the draught behind the car would be liable to blow them out. The waste heat is utilised for raising the temperature of the water before entering the tubes. The engine will develope 8-horse power at 120 revolutions. It has three cylinders at 120 deg., and weighs about 56 kilos. The engine is under the driver's seat, and the power is transmitted to the countershaft by spur wheel gearing. It is possible that something may be done with this mechanism for motor cars, but as at present arranged it appears to be utterly impracticable. The electric carriage builders, Mildé et Cie., had a novelty in the shape of a fore-carriage for light vehicles. It is a circular frame supported on the axle of a single steering wheel fitted with a pneumatic tire. The frame carries 105 kilos. of accumulators, and a small motor, which is geared on to the driving axle by spur wheels. It is claimed that the car will run 70 kiloms. on the level without re-charging. The arrangement is rather cumbrous for a light car, but it certainly appears to open up a new application of electricity for the propulsion of cars. In the lighter types of carriages there was little to be seen beyond the application of systems of spirit engines which have long been on the market. By far the great majority of them had De Dion motors adapted to light vehicles of every possible shape. M. D. Farman, however, exhibited a new tandem car propelled by a two-cylinder horizontal motor, in which the transmission was effected by two belts and two chains, each giving a different speed. The motor is of 4-horse power on the brake. The cylinders are flanged, and are also cooled with water. Instead of circulating the water through cooling tubes the tank, itself serves this purpose by being made tubular, so that there is a very large surface exposed to the air.

If the show has not presented anything that is strikingly new it has at all events indicated that makers are still striving to produce a more satisfactory mechanism than anything that is yet available for road vehicles. All that can be said at the moment is that some of the systems of motor cars are giving very good results, and are so far practicable that the industry has for two years past been making rapid headway on the other side of the Channel; but before these cars can come into general use the existing systems must not only be improved, but there must be a sufficient variety of good mechanisms to prevent the trade being monopolised by a few firms, as is the case at present. From what could be seen at the show, it appears as if makers have little hope of improving the existing motors to any great extent, and certainly it is extremely difficult to devise anything new. Manufacturers, indeed, scarcely seem yet to have made up their minds what direction to take in choosing a definite type of engine. Those who make vertical motors are trying the horizontal types, and those who have hitherto given their attention to the horizontal engines are experimenting with the vertical, while some are endeavouring to make a selection among all sorts of systems. It is true that since the various motor car concerns were formed into companies there is plenty of money for carrying out this purely experimental work, and probably, therefore, the progress in the near future will be more rapid than it has been in the past. The chief difficulty lies in finding some suitable propelling mechanism for the lighter types of carriages, for which there will necessarily always be a very heavy demand. Among the considerable number of light vehicles exhibited at the show propelled by the De Dion motor, there were a few carriages fitted with new engines upon the same principle, and it remains to be seen whether any of these will solve the problem of small vehicle propulsion.

RAILWAYS IN INDO-CHINA.

The loan of eight millions sterling proposed by the Governor-General of Indo-China, and introduced into the Chamber of Deputies with the full support of the French Government, is to be devoted entirely to the construction of a network of railways, without which M. Doumer believes that it will be impossible to turn the rich natural resources of Tonkin and Cochin-China to satisfactory account. The amount asked for is intended to carry out a part of the entire railway scheme, and permit of work being immediately started upon the construction of 1660 kiloms. out of a total length of 4000 kiloms. of line.

The railways will be built in five sections. The most important is the 400 kiloms. of line which will put Haiphong into communication with Hanoi and Lao-Kai on the Chinese frontier. This railway will be eventually extended to Yunnan-Sen by virtue of a concession accorded by China to the French Government, and it will probably be carried out by a company, whose interest on capital will be guaranteed by the Colony. The French attach the greatest value to this enterprise, as not only will the colonial section open up the vast region watered by the unnavigable Red River, but the Chinese extension will put Tonkin into communication with what is deemed one of the richest mineral territories of the Celestial Empire. Yunnan has already been thoroughly explored by French mineralogists and other experts, who express the opinion that the proposed railway will be a very profitable undertaking. The section from Hanoi to Vigne will have a length of 320 kiloms. It will pass through a rich and populous country, and will greatly facilitate the exportation of the natural products. The third section from Kwang-tri to Hue and Tuoron, a distance of 195 kiloms., is regarded more as a strategical line, since it will put the capital of Annam into direct communication with the only accessible port in that country. Nevertheless, between Hue and Kwang-tri the railway will pass through rich cultivated plains that will provide it with plenty of traffic. The fourth section will have a length of 650 kiloms., and will connect Saigon with Kahn-Hoa, while a branch line will go off to the high plateau of Lang-Bian, which is at present almost inaccessible. The climate on the plateau is particularly suited to European settlers, and it is expected that this district will become one of the most prosperous regions in Cochin-China. The fifth section, having a length of 95 kiloms, will be an extension of the existing line between Saigon and Mitho to Cantho, on the south-west, where a large traffic is likely to be done in the transport of rice and other produce. All these sections will be eventually connected up with new railways, and two branch lines will go off to the uplands of Attopeu and the river Mekong, where it is intended to establish a sanatorium for the Government officials.

All these enterprises will provide a considerable amount of work to the French makers of rails and railway material; but as they are very busy just now on account of the home companies, who are spending a great deal of money on the renewal of their plant, in view of the Exhibition of 1900, it is by no means improbable that a good many of the Indo-Chinese contracts will have to go abroad, if it is intended to complete the lines within a reasonable time.

THE JAPANESE DESTROYER, IKADSUCHI.

A preliminary high-speed trial was made on Thursday, the 15th inst., of the torpedo boat destroyer Ikadsuchi, the latest addition to the Imperial Japanese Navy. This is the first of six precisely similar vessels under construction by Messrs. Yarrow and Co., Limited, at their yard at Poplar. These boats are interesting, in that they are larger than anything hitherto attempted in this direction by Messrs. Yarrow, and that their contract speed is 31 knots. The Ikadsuchi is 220ft. long and 20ft. 6in. beam, and has a draught when loaded for trial of 8ft. 6in. aft. Her trial load is 35 tons. On the occasion of this run she had all this on board, and, in addition, she carried seventy-eight persons. The trial was witnessed on behalf of the Japanese Government by Admiral Matsunaga, Captains Kondo and Kurobe, of the Construction Department, and Commander Ishida, who will eventually have charge of the destroyer when she is taken over by the Japanese Government and his staff. The engines are triple-expansion and have four cylinders, the two low-pressure cylinders being at each end of the combination, following the Yarrow, Slick, and Tweedie design, and they are so well balanced that the vibration, considering the power produced, is remarkably small. The sizes of the cylinders are:—High-pressure, 20¼in.; intermediate, 31½in.; and two low-pressure cylinders of 34in. There are two sets of engines driving twin three-bladed propellers, and the estimated horse-power for the contract speed is about 6000, though the engines are said to be quite capable of working up to 7000-horse power if necessary. The stroke is 18in., and the number of revolutions about 400 per minute.

There are four boilers, two for the port, and two for the starboard engines. These boilers are of the ordinary Yarrow water-tube type, and are capable, if pressed, of doing well over 1500-horse power each; each boiler has its own funnel. There are two stokeholds, the boilers being placed so that two can be fed from one hold, through the three furnace doors with which each is provided. The forced draught is worked by means of a horizontal fan, 6ft. in diameter, the spindle of which descends to the level of the stoking floor, where it is connected to a small horizontal engine; there is therefore one fan to two boilers. The boilers are constructed for a working pressure of 250 lb. on the square inch.

The electric equipment, for which Messrs. Siemens Brothers are responsible, consists of forty-two fixed 16-candle power lamps, three navigation lights, three signal lights, and a 20in. projector of 20,000-candle power, provided with an automatic lamp, Mangin mirror, and dispersing lens. The dynamo, which gives 100 ampères at 80 volts, is of the Admiralty pattern, and is coupled to a Bellis tandem compound enclosed engine, running at 500 revolutions per minute. The armament consists of a 12-pounder quick-firing gun, mounted aft, and a broadside of five 6-pounder quick-firers. There will, in addition, be two 18-in. torpedo tubes. These will be placed aft, and will be capable of swivelling. There will be storage room for six torpedoes. The coal-carrying capacity of these boats is 90 tons, which is capable of taking them at economical speed for a distance of over 3,000 nautical miles. The coal is carried in bunkers situated at the sides of the vessels. The officers' quarters, which are much more roomy than in the generality of destroyers, are in these particular boats placed immediately aft of the engine room, from which, they are separated by a bulkhead.

On the occasion of the trial, an early start was made from Poplar, and the vessel was taken down to the Maplin measured mile, and put to full speed. She more than fulfilled her contract, for she attained a speed of well over 31 knots, with a steam pressure of only 185 lb. on the square inch, a vacuum of 25in., and just over 400 revolutions per minute of the engines. The official trials are shortly to take place.

THE DERWENT AND ASHOP WATER SUPPLY SCHEMES.

A smart parliamentary struggle over the rivers Derwent and Ashop is likely to take place soon. Leicester, Sheffield, and Derby are each contending for entire control of the head waters of these rivers, with the primary object of supplementing their existing water supplies. Without for a moment suggesting which of these towns, if any, should be permitted to take the whole or part of this water, we propose to give some idea of the nature of the water supply; to describe the schemes as at present suggested; and to set out what are the claims which each town puts forward to being a participator in the water.

All three schemes aim at impounding the head waters of both the Derwent and the Ashop, either by means of reservoirs on these rivers themselves, or else by a reservoir just below their junction. We hear that a number of attempts have been made by the three towns to come to some general understanding between themselves, but these have fallen through, apparently because each one wishes to play the leading part.

The rivers Derwent and Ashop both rise in the Peak country, the former just on the borders of Derbyshire and Yorkshire. They come together at a place called Ashopton, Fig. 5, a pastoral village of the true Derbyshire type, with its famous inn, a relic of the old coaching days. It is charming country, and is the watershed of the Derwent. It comprises 23,000 acres, which contain as a total but 100 inhabitants, and it is only very slightly cultivated. At the source of the

DERWENT AND ASHOP GATHERING GROUNDS

Fig. 1—"SLIPPERY STONES" NEAR SOURCE OF DERWENT

Fig. 2—THE DERWENT AT RONKSLEY MEADOWS

Fig. 3—THE DERWENT NEAR OUZELDEN CLOUGH

Fig. 4—THE ASHOP NEAR HAGGLEE FARM

Fig 5—THE CONFLUENCE OF DERWENT AND ASHOP

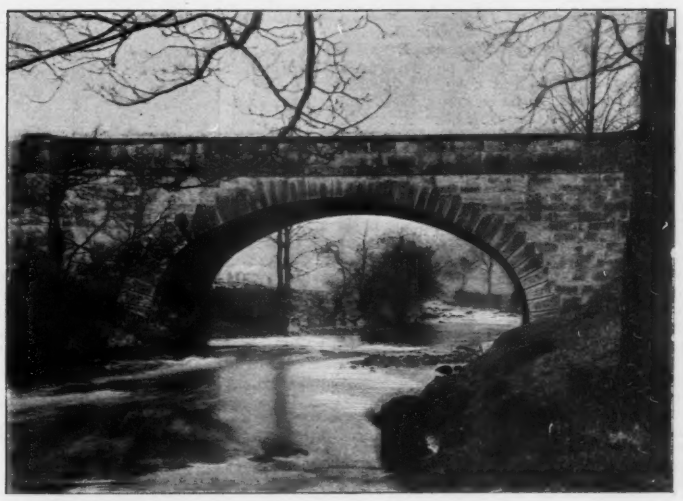


Fig. 6—THE DERWENT NEAR ASHOPTON

Derwent, near Slippery Stones, Fig. 1, as a local authority says, one finds himself "absolutely alone with earth and sky, save for the bleating of the startled sheep or the crowing of the grouse he disturbs as he walks along." An ideal spot for obtaining pure water; indeed, the water is said to possess an extremely high degree of organic purity, and according to a report made by Sir Edward Frankland, it is remarkably soft, being almost entirely free from salts of lime and magnesia, and for dietetic purposes one of the best in the kingdom. Of the rainfall, strangely enough, there does not appear to be any direct evidence forthcoming. The valleys of the Derwent and the Ashop, it is stated, have never been gauged. The fall in adjoining valleys, however, has been taken for a lengthy period, and the results there obtained point to the fact that somewhere about 40in. of rain may be expected in ordinary dry seasons in the valleys now under consideration. On this basis it is calculated that 30,000,000 gallons may be expected to be realised as a daily average.

Of the three schemes, that of Leicester is the most daring, if for no other reason, certainly on account of the distance to which the water is to be taken, some 66 miles. Sheffield is very much nearer, only 10 to 12 miles off, and it is extraordinary that this town should not have gone to this source before. The Leicester and Derby schemes are similar in design.

Taking them in detail, the Leicester scheme is the outcome of a large amount of thought, and has only been adopted after careful search and investigation in other directions. First of all, Loughborough was suggested as a possible source, this town having acquired more water than it is likely to require for its own uses for many years to come. This project was discarded because it was found that, supposing in the future Leicester had to further increase its supply and carried out such another scheme as the present Derwent project, it would still have to pay Loughborough for fifty years, whether it used the water or not. It had also been in turn suggested that water should be obtained from Bardon Hill, Twyford and Mere, Eye Valley, and Rutland. Each scheme, however, had to be given up. Then it was attempted to obtain a supply from Birmingham, but not only would this have been accompanied by a large expenditure of money in Parliament, but the cost of the mains would have been more than the cost of the Derwent project. Eventually, therefore, it was decided to adopt this. It provides a total of five reservoirs, though at present it is only proposed to form one. The five reservoirs are as follows:—

(1) *The Ronksley Reservoir.*—This is situated about five miles up the Derwent from Ashopton. It will have a masonry dam, and contain 921 million gallons. Fig. 2.

(2) *The Ouzelden Reservoir*, the masonry dam of which will be built across the Derwent, some 3½ miles north of Ashopton, and the water in it at its highest point will reach the base of the Ronksley Dam, the reservoir being some 1½ miles long. It will contain 2530 million gallons of water. This is the first of the reservoirs which it is proposed to construct, and from it 12,000,000 gallons daily will be drawn. Of this, at present, Leicester proposes to take 5,000,000, giving Derby and Derbyshire 7,000,000 gallons. From this reservoir it is suggested to lead an aqueduct to conduct the water southwards, and compensation gauges and storm overflows are arranged for. Fig. 3.

(3) *The Blackden Reservoir.*—This is on the Ashop, some 4½ miles above Ashopton. Here, again, the building of a masonry dam is proposed, and the suggested capacity of the reservoir, which will be a mile long, is 467 million gallons.

(4) *The Hagglee Reservoir.*—This completes the storage reservoirs so far as water supply is concerned, as No. 5 is only intended for compensation purposes. Here, again, there is to be a masonry dam, supplied with overflows and compensation gauges. It is to be placed near Hagglee Farm, some 2¼ miles north-west of Ashopton, Fig. 4, and the reservoir is to contain 2161 million gallons, so that the total suggested storage, when the whole scheme is carried out, is as follows:—

Derwent	Ronksley Reservoir	921	million gallons.
	Ouzelden "	2530	" "
Ashop	Blackden "	447	" "
	Hagglee "	2161	" "
Total		6079	

From the Hagglee Reservoir the Leicester scheme proposes to take a tunnel 1200 yards in length to join the aqueduct coming from the Ouzelden Reservoir, rather more than a mile from its commencement.

(5) *The Bamford Reservoir.*—This will be the last to be constructed, and will only be used for a compensation reservoir. It will be constructed with an earthen dam, and will contain 2502 million gallons of water. At Bamford also there are to be fifteen filter beds, which are to be constructed in three groups of five filter beds each.

From this point the water will be led through alternating cast iron pipes, concrete conduits, and tunnels, to service reservoirs at Ambergate, 637ft. above Ordnance Datum, which will eventually hold 30,000,000 gallons, but at first only 5,000,000 gallons. From here supplies could be taken to Derby, or any other town which might require them, and water could be led by gravitation to service reservoirs in the neighbourhood of Leicester. It is an important scheme, and if only the first part of it be carried out the estimated cost is £1,520,000. One cannot but admire the pluck and enterprise exhibited by Mr. Everard, the engineer to the Corporation of Leicester, in working out and bringing forward such a scheme—a scheme which has for its object the impounding the whole of the upper waters of the Derwent and Ashop, together with all their tributaries.

The Derby scheme is practically as elaborate as that of Leicester, and it provides for no less than eight reservoirs. The series begins with the Ronksley reservoir, with a dam across the Derwent half a mile north of Ronksley Farm, and extending about a mile and a-quarter up the river from that point. Next is the Howden Reservoir, also on the Derwent, but extending up the tributary river West End as well; a third reservoir on the Derwent would be situate about the confluence of the Derwent and the Abbey Brook. Derby's No. 4 reservoir, to be called the Woodlands Reservoir, would drain the Ashop and the Alport; No. 5, the Ashopton Reservoir, situated near Ashopton Bridge, would take the remainder of the Ashop waters just before that stream enters the Derwent; No. 6, to be called the Bamford Reservoir, would continue the line of reservoirs on the Derwent from Ashopton Bridge to Bamford Mills. The two other reservoirs would be the Hilale Reservoir, on the river Noe, with a dam near Barber Booth; and the Burbage Reservoir, draining the Burbage Brook, and situated a quarter of a mile above and below Burbage Bridge. The pipe lines, conduits, &c., from the various reservoirs would in the Derby scheme converge into a huge service tank at Crich, below Ambergate; and there would be additional service tanks at Bargate, near Belper, and at Little Eaton, just outside Derby.

The Sheffield scheme is considerably less pretentious than either of the foregoing. It proposes the construction of three large reservoirs on the Derwent, one near Slippery Stones, to be called the Howden Reservoir; one immediately below this, to be called the Derwent Reservoir, and extending as far down stream as Ouzelden Bridge; and a third, to be called the Bamford Reservoir, skirting the foot of Win Hill, from the junction of the Ashop and Derwent down to below Yorkshire Bridge. Further, the Sheffield Bill proposes to put a weir across the Ashop above Alport Bridge, and from above the weir to convey the waters there collected through an aqueduct or tunnel into the Ouzelden Brook, which falls into the Derwent above the proposed Derwent Reservoir. By these means, and by means of pipe lines from the reservoirs to the city, the Sheffield Corporation will be enabled to secure the waters of the Derwent, West End, Alport, Lady Clough, Cranberry Clough, Abbey Brook, Ouzelden Brook, Lady Bower Brook, and their tributaries.

As will have been seen, each town in succession proposes to acquire rights over the whole of the watershed, and it is interesting to note the avowed intentions of each one. Leicester proposes to supply Derby and Derbyshire in addition to itself and neighbouring towns; it even in the first instance proposes to give to Derby and Derbyshire more than half the total amount of water to be obtained, and suggests a joint Water Board. Derby says nothing about Leicester, which is not to be wondered at considering the distance between these two towns, every yard of which is going further away from the source. Derby only professes to act on its own behalf and on that of Derbyshire, inserting clauses to give itself power to share responsibilities with the Derby County Council, and other Derbyshire authorities, and also to empower it to sell water in bulk. Sheffield mentions neither Derby nor Leicester, but it is proposed to share the water with Rotherham and Doncaster—both of them further away from the source of supply than itself—and provides for a joint Committee representing the three Corporations to settle the terms upon which Rotherham and Doncaster are to be supplied.

And now as to the claims which the various towns can have upon this water. How comes it that Sheffield, in Yorkshire, and Leicester, in Leicestershire, can have any claim upon the water of a river which rises in a different county, and which in the case of Leicestershire does not flow through one inch of its soil? The answer to questions such as these has already been given in the case of the water supply of Manchester, Liverpool, and Birmingham. If a large community can prove its needs and formulate a workable scheme, it will be allowed to carry it through, in a more or less modified form, according to the opposition it has met with.

Sheffield has for some years now been looking far into the distance with respect to its water supply. Already this town has the use of the waters of the Rivelin, Loxley, Ewdon, and Little Don Valleys, but it is not fully persuaded that its water supply is ensured sufficiently far ahead, and hence its present attitude. The waters of the Derwent form Sheffield's last resource before going to, say, the Lake district for water. It is difficult to understand why it has not acquired the Derwent supply before. Six years ago it was recommended to do so, and there is every reason to believe that it would have been allowed to make use of the Dore and Chinley tunnel, which would have been exactly at the right level for the pipes. Whether or not it will now be able to prove that it is in such want as to warrant permission being given to it to go into an adjoining county for further supply remains, of course, to be proved; but, in addition, the town is prepared to contend that it has *primâ facie* rights; that the boundary between Derbyshire and Yorkshire follows for a great distance the ridge which parts the watersheds of the Derwent and the Don; that there are gathering grounds in Yorkshire dipping towards the Derwent; that five of the six feeders on the left bank of the Upper Derwent are wholly in Yorkshire, and that for some distance from the point where the Abbey Brook joins the Derwent this latter is the county boundary right up to its source. So much then for the claims of Sheffield. Derby evidently does not recognise the claims of anyone but itself and the county which bears its name. From their point of view this is very natural. The whole length of the Derwent is in Derbyshire, although it forms part of the boundary with Yorkshire. Not only this, but Derby is actually on the Derwent, and therefore claims the exclusive right of dealing with the upper waters and regulating the amount of water flowing in the river. This point, we may be sure, will be most carefully attended to whichever of the towns may in whole or in part obtain water from the Upper Derwent, for Derby depends largely in its commerce on water power derived from the river.

The claim of Leicester to the Derwent is that it is the nearest source from which it can obtain a sufficient amount of water for its present and future needs, and it will doubtless urge that these needs are, even at the present time, very pressing, and that it has exploited a large number of other sources without success. Leicester further claims the water almost as a right, since it is in the watershed of the Trent, contending that its claim is just, as the Derwent flows into the Trent, and that, at any rate, Sheffield can have no participation in this source of supply, as the town is in the watershed of the Ouse. Leicester, however, does recognise that Derby has a good claim to the water, as is shown by the provision it makes in its Bill.

"IMPROVEMENTS" IN PRESERVATIVE PAINTS.

THE subject of preservative paints for exposed ironwork is so important to all constructional engineers that a brief sketch of some recent investigations and improvements in the direction of preparing a more efficient material than those at present found on the markets may perhaps be welcomed by our readers.

Oxide of iron colours, which are among the most highly favoured pigments for linseed oil paints, are usually manufactured by igniting at a high temperature in a muffle furnace some raw mineral or by-product, such as yellow ochre or crude sulphate of iron. Furnacing for a short time or at a comparatively mild heat yields a dark-brown oxide; if the operation is prolonged or the fire urged, the colour gradually changes to a light brown, then to a red, afterwards to a reddish purple, and finally to a dark purple. Evidently, therefore, the product becomes more expensive as its shade alters from brown to purple, even though each and every such material may be almost equally composed of pure ferric oxide, varying solely in its physical characteristics. Experiments have lately been instituted by Baucke with the view of deciding whether there is any practical advantage to be gained in using the more costly—*i.e.*, purple—grades of oxide as the basis of a purely preservative paint; for it is clear that the colour, *qua* colour, is a matter of quite secondary importance. Bearing in mind that much engineers' paint is employed for railway work, such as bridges and roofs, where the substance is constantly exposed to the peculiarly corrosive influence of the acid exhaust from coal and coke fires, Baucke has specially studied the behaviour of iron oxide towards dilute inorganic acids. He finds that the pigment undoubtedly becomes more resistant the longer it is furnaced or the more severely it is ignited, and that chemically a purple oxide is more valuable than a brown one. Making proper allowance for the increasing cost, he considers a distinctly red oxide the best of all, and suggests that such a material shall be chosen for most industrial purposes. As the colour changes during the process of manufacture, so also the specific gravity of the oxide rises, always assuming that the ochre, &c., is reasonably free from heavy impurities. Again considering expense, he shows that a density of 4·2 is the most suitable; and he proves that this figure may be utilised as a means of gauging the commercial value of the pigment.

An English patent—No. 28,484, 1897—has recently been taken out by H. Loesner, who is well known to all readers of German industrial chemistry as a painstaking investigator of the relative protective capacity of different varieties of paint and varnish. His process consists in grinding some colour into linseed oil in the presence of a certain proportion of hydraulic cement, or cement diluted with sand. Precautions are taken to prevent the cement from absorbing water before the paint is applied to the ironwork; so that when the film is finally exposed the new ingredient is slowly caused to set by means of the moisture present in the surrounding atmosphere; at length producing a thin layer of hardened cement, or cement-mortar embodied in a paint of conventional composition, in which the former provides the waterproofing qualities, and the latter the colour and general appearance of ordinary paint. The patentee claims that the introduction of cement in this fashion does not militate against the proper spreading of the material, and that the product is satisfactory in every respect, being absolutely damp-proof and permanent.

The same chemist has also elaborated a quick method of testing paints to determine their moisture-resisting power. This is known as a "steam test," and, being simple to carry out, may conveniently be described here. Pieces of sheet iron are thoroughly freed from rust on one side by friction with emery cloth, then coated with a thin film of paint, and set aside to dry for four days. A second coat is next applied, and also allowed to harden for the same period of time. A vessel containing water is made to boil vigorously, narrow strips of wood are laid across it, and over them are placed the pieces of iron, painted side downwards, in such a manner that the films are completely surrounded by the rising steam. The water-bath is so arranged that the level of the liquid can be maintained at a uniform position, which is, throughout the whole test, always 50 mm. below the metal plates. After about fifteen hours' boiling the paint is dried at 100 deg. Cent., removed from the iron by the aid of aniline and a brush, and the surface of the metal is carefully examined for spots of rust. If the iron be not corroded the paint may be considered fairly weatherproof; for the author calculates that one hour of his steam test is equivalent to two or three months' exposure to wind and rain. Twelve hours may be taken as the minimum period of resistance for a good paint; scarcely any kind of composition will withstand the steam longer, except the patent material described in the last paragraph.

A series of comparative trials with different varieties of oil paint applied to wood, tin, galvanised, and plain sheet iron has been carried out by G. R. Henderson, in America. The test pieces were given two coats and exposed for a year out of doors in a south light. Tin and galvanised iron lasted best when protected with a first coat of white lead and a second coat of zinc white. Sheet iron appeared to prefer a mixture of two-thirds white lead and one-third zinc white in each coat. Poplar and white deal behaved satisfactorily with either pigment alone or both together; "yellow" was more difficult to paint, but lead for the priming coat was indicated.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH AND AMERICAN MACHINE TOOLS.

SIR,—Mr. Hugh Campbell, in his letter on "British and American Machine Tools," which appeared in your issue of the 9th inst., makes several incorrect statements regarding "the one firm in this country who has a line of key-seating machines." As representing the firm referred to, I must apologise for having to touch upon personal matters; but Mr. Campbell has given your readers only one side of the question, and I should therefore like to put the real facts before them. These are as follows:—Mr. Campbell ordered a large size keyseater from my firm on the 18th December, 1896, and was distinctly assured at that time that delivery could not be effected in less than from five to six months—*i.e.*, 18th June, 1897, as the latter limit—owing to our being exceptionally busy at the time, and because the machine would need special alterations to suit Mr. Campbell's requirements. When quoting, and also on receipt of order, we drew Mr. Campbell's attention to the fact that cutter bars were essential to the machine, and that those to suit his machine, being special, would take almost as long to make as the machine itself. In spite of these admonitions, Mr. Campbell did not order these cutter bars until 21st June, 1897, or six months after we received the order for the machine itself, and then, forsooth, cancelled the orders for machine and cutter bars less than a month after, on July 19th. There was no question of cancelling the order because of delay in delivery, until we had to inform Mr. Campbell that our men were out on the forty-eight hour question. Then, although we assured him that there was only ten days' work required to complete the machine, when we got our men back again, he pleaded continued delay—*i.e.*, one month in excess of our estimated time—and cancelled the order.

Mr. Campbell's firm was not amongst those who came into line and fought the forty-eight hour and machine questions, and had not backbone enough to fight for the very existence of the engineering trade in this country. It gives me much pleasure, therefore, to here record that this order was the only one we had cancelled by an English firm owing to that dispute.

Turning to Mr. Campbell's letter generally, if he had been as well informed on the subject of British as he appears to be on that of American machine tools, he certainly would not have put pen to half the statements he has made, as they will not bear the test of the most superficial examination. For instance, Mr. Campbell states that "boring and turning mills were not built in England until a couple of years ago, and then only in small sizes by Messrs. Richards and Co., of Manchester." It will no doubt surprise Mr. Campbell to learn that my firm has been building boring and turning mills steadily since May, 1889, in sizes ranging from 2ft. 6in. to 20ft. in diameter, but—alas for the British enterprise!—75 per cent. of these were for the Continent. The question of delivery is one that could easily be met in ordinary times; but the whole British machine tool trade is at the present time so abnormally busy that quick deliveries are an impossibility, hence the American opportunity. That many orders pass us on this account—and this account only—for these very machines, we have had ample proof lately, but the output of a works is limited, even when the plant has practically been doubled in the last three years.

Again, referring to capstan and turret lathes, Mr. Campbell says, "What firm or firms in this country, except Alfred Herbert, Limited, of Coventry, can show us such a line of these tools for both bar and casting work as the Americans?" Has Mr. Campbell ever heard of Alfred Muir and Co., of Manchester, who have been building the American type of capstan lathe for years, and does Mr. Campbell realise that my firm build their own types in nineteen different sizes on five different models? No doubt it will surprise Mr. Campbell to learn that we have taken orders for over sixty capstan lathes this year, and could, without doubt, have taken orders for half as many again had we not had at least six months' work on the books throughout the year. Surely these figures point to the fact that one British type of capstan lathe at the least holds its own. I might also in this connection remind Mr. Campbell that my firm were the original patentees of the chasing lathe, the screwing die box of which is so important a feature of the capstan lathe, however made. As to the claims Mr. Campbell makes for American drill presses, we are perfectly willing to dispose of two, a 25in. and a 32in., to him; they are built by an American firm of good repute, but will not hold their own, even when pitted against smaller sizes of drilling machines made by ourselves, in such essential points as accuracy, stability, or capability of production.

I must apologise for trespassing at so great length on your valuable space, but I hope your readers will have gathered from my remarks that Mr. Campbell and those who seem, at the present time, to take a delight in belittling the enterprise and ingenuity of the British machine tool makers, appear to those who have some knowledge of what has been done, and is being done, in both England and America, to be simply retailing some of the glib, though often erroneous, statements made by the ubiquitous American representatives who have recently inundated this country. As a case in point, let me relate an experience of my own: An American was enlarging to me on the advantage of making a certain thing in a certain way, and when I pointed out to him what an utter fallacy he was supporting, he backed out with the words "Well, at any rate, it gives us something to talk about."

THEODORE COVENTRY.
(Smith and Coventry, Limited.)
Salford, Manchester, December 19th.

SIR,—I have read with interest the leading article in your issue of the 2nd inst., and Mr. Campbell's letter in your current number. His letter very ably supports your view, and goes further, but, in my opinion, not too far by any means. I have during the last ten years taken a deep and close interest in this most important industry, and in 1893 I read a paper on the subject before one of the London engineering societies, and at the present time am writing a series of articles in one of your contemporaries; and it is the competitive side of the question that seems to me so important—I mean American enterprise and English indifference. I am not interested in any way whatever with any American firm, but it is sheer folly to imagine that if things go on as at present we shall retain our position. At first they came with hand tools, and few firms here can beat them in that line; then light tools, such as sensitive drills, turret lathes, light milling machines, and so on, and now they have commenced to supply heavy tools in earnest. If anyone thinks this is not so because he does not see many heavy machines in stock, he may learn that it

has now become a practice to cable for heavy tools, and, what is more, get very prompt delivery—certainly quicker than they can be got in England in most cases.

Our tool shops are busy, I know, but the Navy boom will not last for ever; and, as you very ably pointed out in your leader, the cycle boom is on the wane. As an Englishman, I should be glad to see only English tools used here, but I venture to think he is a greater patriot who encourages his countrymen to maintain their superiority than to shout out that their products are the best when really they are inferior. I do not hesitate to say that we can make as good a tool as any country, but I doubt if we are doing so at the present moment; but whether we are or not, we are at any rate giving our American friends the opportunity to flood our market largely on account of our want of enterprise. How many English firms have show-rooms in London? How many exhibit in any way outside their own shops? If American firms can sell the first-class tools they are offering at a profit after paying a high wage rate and costly freight, then I submit we ought to do the same and go one better, but we must be prepared to spend money and burn a good many patterns.

London, December, 14th. E. C. AMOS, M.I.M.E.

SIR,—With reference to Mr. Hugh Campbell's wholesale onslaught on British machine tool makers in your last issue, we wish to correct a rather damaging statement of his, that no firm in this country can offer a good planing machine, cutting at 20ft. and reversing at 80ft. per minute. We are making a speciality of planing machines, and these speeds on a noiseless running machine are our ordinary practice. Our standard machines also embody advantages which, we have good reason to believe, are not on even the best and most expensive American planers, viz., an additional slow-cutting speed of 12ft. per minute for extra hard material, and having correspondingly increased driving power, automatic lifting motion to the cutting tools during the return stroke, the total avoidance of torsional strain on main gearing shafts, and consequent spring. We might mention many other points of interest in planers to show that, as regards up-to-date improvements, we are by no means content to take a back seat. It is evident that Mr. Campbell is not acquainted with the younger firms in the tool trade. We instance one machine only of those mentioned by him as it most directly affects ourselves.

CLIFTON AND WADDELL,
Machine Tool Makers.

Johnstone, Scotland, December 13th.

SIR,—What "A Fitter" says about a horizontal lathe in Woolwich Arsenal 25 years ago is quite true. It is, however, within my knowledge that this kind of machine, which was then, and is now, very rare in engineering workshops in this country, was already at the time he names one of the tools most frequently met with in similar works in the United States.

Is the slowness with which they are coming into use here due to our innate conservatism? Tools of this class are exceedingly useful, especially for dealing with irregular work, which is very awkward to bolt on to a vertical face plate, and which necessitates troublesome counterbalancing.

Then also many articles can be most conveniently faced in a horizontal lathe, instead of being planed in a planing machine, thus avoiding the loss of time involved in the running back of the planing machine table.

As regards the general question of American *v.* English machine tools, my experience and observation, gained in both countries, lead to the conclusion that in the smaller class of machine tools the Americans have generally led the way, and that there has been a great improvement of recent years in their heavier tools.

36, Paradise-street, Birmingham, W. H. THORNBERY.
December 17th.

SIR,—Allow me to draw attention to a remark in your most interesting article, in the issue of November 25th, on the Linotype works, which, although perhaps literally correct, is still misleading.

Speaking of the bright cold steel bars, you say the American can be procured at £13 per ton, whereas the bars which were supplied by Sheffield firms, and supposed to be similar, but really very inferior, cost £23 to £24 per ton.

Now, as a matter of fact, we are regularly getting from a Leeds firm odd shafts of bright cold rolled steel, 3ft. to 22ft. long, of the highest quality and finish, cut to dead lengths and square centred, at a cost per ton for 1in. diameter, £15; for 2in. diameter, £13 10s.; for 3in. diameter, £13 10s. less 2½ per cent. delivered free.

Manchester, December 19th. G. M. H.

THE PATENT-OFFICE LIBRARY.

SIR,—Those whose business takes them to the Patent-office Library are considerably indebted to both your journal, and to your contemporary *Engineering*, for much of the improvement that has been introduced there in late years, rendering it more serviceable for the purpose for which it is primarily intended, namely, that of a reference department of the Patent-office. I was pleased, therefore, to read the leading article thereon in your issue of the 25th November, as the question of the future disposition of this unique and valuable collection, and the plans relating, as intended to be carried out in the new premises, ought to be made known in good time before occupation, so that due consideration may be given to suggestions offering for the much needed amendment in the system.

The essential points to be kept in view are ably put by your correspondent Mr. Thomas Pinch, with the principal of which I agree. All the arrangements should aim to make this strictly a reference library, whereby the reader may find for himself the matter he is in want of, with no aid from a librarian. Granted those in charge are ever most ready to supply information when applied to, the very fact of having to requisition the assistance of others, who know nothing of the matter relating to the search, is in many cases more of a hindrance than help. An example of this necessity for the discoverer to search for himself may be given by referring to the new system curtailing the use of periodicals introduced since occupation of the temporary premises. Thus, say information be required relating to the use and advantage of some particular pump, or any machine in general use, details of the working of which might be found in any one of the number of periodicals devoted to engineering and mechanical subjects. Now, current numbers of periodicals must be asked for as required, so that, to satisfy a search in the above-mentioned instance, each journal file would have to be sent for separately, entailing much loss of time, or, as would more probably be the case, abandonment of the search. This inconvenience may be further exemplified by pointing out that unless one regularly follows the week's literature, it must be considered lost, unless one is prepared to wait, in the same way, for each file as sent for. The cramped accommodation under which current periodicals may be perused induces me to think that many must forego the privilege.

The deprivation of half the library now stored in the incommodious "Stock Room" must also be a serious loss in time, if not otherwise, to a great many, and consequently is no doubt an indirect loss to the Patent-office itself. A building with the requisite accommodation might well have been afforded, considering the large yearly revenue surplus coming from those who, either personally or by representative, resort there.

As regards the catalogue, it occurs to me that the "subject matter" is more important in this Library than the "authors," yet, as I understand, this half of the catalogue is not to be issued for another twelve months.

Touching the system of subject matter reference, I venture to suggest that it might be useful if the "Class Index" to the Abridgment of Specifications had the Press reference of any work or works in the Library wherein matter might be found bearing upon the subject.

December 14th. HENRY BROCKELBANK.

SIR,—In your interesting leader of the 25th ult. there are one or two points which I think may lead to misapprehension on the part of your readers as to the arrangement, scope, and value of the Patent-office Library.

Speaking as one who has used this library for many years in preference to any other, for consulting technical and general scientific works, I can only say that the arrangement serves my own purpose better than any other. All the works relating to each subject are placed together, and the reader can refer to them without filling in any form of application, &c. Above all, the courtesy and knowledge of Mr. Hulme and his staff are always available to an extent which I have not found to be the case at any other library.

It must be remembered that the Library is intended primarily for the inventor; and, secondly, for the technical and scientific searcher, and it is, of course, impossible to provide a perfect library in such cramped temporary premises; but it appears to me that we are furnished with as thoroughly "scientific an arrangement of the volumes" as could be supplied. The works which are ranged on the shelves are those most required, and any others can be obtained for the asking, while as to newly published works, the Patent-office Library seems to me to be generally first in the field. Of course questions of finance constantly clip the librarian's wings, but the flights which he is enabled to take invariably bring down the best quarry.

For technical and scientific journals, both British and foreign, the Patent-office Library undoubtedly occupies the premier position among our public libraries.

As to the cataloguing, I do not know what system of authors' catalogue, other than that adopted, could have been used. The numbers given after each entry are merely "accession" numbers, and, of course, the Dewey or any other system for press-marking them would be useless for temporary premises. Although I may say that in the catalogue—available for reference at the Library—additional marks indicating the position of the works on the shelves are added.

Finally, there exists for reference a MS. list of the periodicals, and I invariably find that all the reference catalogues at the Library are kept absolutely up to date.

The importance of the subject dealing with our public libraries, and with the cataloguing of their contents, cannot be over-estimated, and I trust that the publicity which you have given to the matter may result in an increase of the grant to this valuable library.

57, Chancery-lane, W.C., GEORGE T. HOLLOWAY.
December 13th.

THE INSTITUTION OF CIVIL ENGINEERS' ENTRANCE EXAMINATION.

SIR,—The thanks of the profession, especially those of members of the Institution, are due to you for your able article upon this subject in your last issue.

I have followed with great interest the correspondence you have published, and as it was my letter in your issue of November 4th that gave rise to the discussion, I shall esteem it a favour if you will allow me to supplement it with one or two further remarks.

My friend, whose papers induced me to write in the first instance, duly passed the examination, as he well deserved to pass, if the time he had devoted to reading and cramming was not to be afterwards looked back upon as utterly thrown away. It is just this cramming of superfluous mathematics, in order to come up to the level of these papers, that is the bone of contention, and much will be gained if the Council will adopt the suggestion you make to supervise and render practical the papers submitted by the examiners. A certain amount of theory is not only essential, but indispensable; when, however, it comes to such questions as have recently been criticised, the examination for an engineer approaches absurdity. The large majority of candidates pass because they have read up for it, but as you point out, few would pass without special preparation, not even members of the Council itself.

Sir, the policy of the Institution in initiating entrance examinations is right without question; the papers set, however, are undoubtedly wrong, and it is in the latter that amendments are needed. One other word. You published in your issue of November 11th a letter signed "M. Inst. C.E." which might have almost been supposed to cover a semi-official pronouncement by the Council. The increase in candidates, and the large percentage who pass the examinations, in no way "form a complete answer" to the objections that are raised against the papers; they tend, in fact, to emphasise the importance both to the Institution and to the candidates of putting the papers upon a basis of actual engineering value rather than, as at present, of high mathematical proficiency abnormally attained.

December 18th. ASSOC. M. INST. C.E.

AUTOMATIC GAS METERS AND COOKERS.

SIR,—As a side issue to the engineering world, the rapid development of the penny-in-the-slot system which has astonished the millions, demands something more than a passing notice. Perhaps one of the most surprising adaptations is that for gas distribution. The enormous success of this system is possibly due mainly to the reasonable desire of the public for knowing what they are buying, the cash payment, and also to the immense popularity of the penny worth.

To such a state of perfection have automatic gas meters been brought, it is impossible to foresee to what extent they will be ultimately extended. It is probable in the near future that different rooms, workshops, offices, &c., of the same institution will control the consumption of what is required for lighting and heating purposes by automatic interception meters, rather than allow an indefinite quantity of gas to be used without regard to cost, as in many cases existing at present. Such waste not only affects the cost of production of materials, but also the health of the workers, which is of the first importance. It may be found advantageous where rooms are let as apartments in houses or hotels to allow each tenant to be responsible for their own amount of gas, in preference to the unsatisfactory fixed charges so generally made. For internal arrangements in workshops, slot meters might be employed by a mutual arrangement with the head of the department and the employés. Of course, in such a case the meter would be the property of those directly concerned. The meters being fixed in a passage or landing, can easily be available for examination and collection from time to time. In cases of illness the ready check afforded upon the consumption of a bedroom stove is a satisfactory element. Applications for automatic meters are so numerous that few gas undertakings can afford to be independent of the assistance afforded by them. It is not so much the financial side of the matter as revenue earners that has to be considered as the popularising of gas in every home, office, or workshop. It has recently been pointed out that for city and town offices a gas fire is perhaps as useful a system of heating as can well be used, no attention being required from the time the stove is lit in the morning to when it is turned off at night, thus saving not only time in this, but avoiding annoyance of too large or too small a fire and other attendant inconveniences. For bedrooms gas fires are becoming increasingly popular. Where properly fixed, and connected by a flue direct into the chimney, this method of heating is peculiarly suitable. The temperature of a room can be maintained most evenly night and day, which in several cases of illness is of immense importance, while the necessity for making the fire up, and thereby disturbing a patient, is dispensed with. There is, moreover, the additional important consideration that the fire is always available. To those affected with asthmatical, bronchial, or kindred complaints, this cannot afford to be disregarded, especially considering the liability of a sudden attack, which often occurs in the middle of the night, when some hours must frequently necessarily elapse before a coal fire can be got ready. If this notice were from a medical point of view instead of from an engineering one, much might be said in respect upon this subject. The omission of reference to the convenience obtainable in cases of illness would, however, render any notice of gas fires incomplete.

Many gas undertakings are now recognising the importance of giving every facility for supplying gas fires, are fixing them free of cost, and only making a nominal annual charge for the stove. The undertaking of which I have the honour to be the engineer is doing this with good results. In consequence of what has become to be known as the "fixed free" stove business, the numerous stove and meter makers have been inundated with orders, the delays occasioned in consequence being vexing alike to the consumer and the gas officials. The method of calculating the desirability of adopting this penny-in-the-slot system is easily calculable. My experience is that for an ordinary automatic meter for lighting purposes only, the annual gas consumption therefrom equals 10,000 cubic feet, and where a small cooker is supplied this consumption is doubled. This quantity of gas at the profit on cost of manufacture per thousand will furnish the income available as interest on the small original outlay, depreciation, and the extra cost of collection. From 20 to 35 cubic feet of gas for a penny is the general charge. An ordinary flat-flame burner consuming 5ft. per hour will thus last from four to seven hours, or where an incandescent burner is used, consuming from 3 to 4 cubic feet per hour, the time the pennyworth will last is proportionately longer. Generally speaking, gas undertakings supply fittings, burners, meter, and stove, free of cost, so that the consumer's maximum liability is only one penny. My experience is that the addition of a small cooking stove is as great a convenience comparatively in small class property as in large, where gas cooking stoves are considered well nigh indispensable.

Such a development in one of the branches of the great engineering profession is truly astounding.

Corporation Gasworks, Huddersfield, EDWARD A. HARMAN.
December 19th.

HIGH-SPEED AIR PUMPS.

SIR,—Having had considerable experience with high-speed air pumps, more especially when in charge of one of H.M. torpedo gunboats, the following results obtained from a small Edwards air pump running in a launch under my supervision have been of interest to me, and may also interest others. The pump was working under unfavourable conditions, viz., with an outboard condenser, with which, as many of your readers will know, it is often difficult to obtain good results with the ordinary air pump; the action of the latter, generally speaking, being irregular, and the vacuum at its best not being particularly good. At 420 revolutions per minute the vacuum was 29in., at 450 revolutions 28⅝in., and at 500 revolutions 28¼in. The reduction in vacuum at the higher speeds evidently was not due to any fault in the pump, but due to the temperature, as at each of the speeds the highest vacuum permissible with the existing temperature of feed was obtained. The action of the pump was all that could be desired, and the discharge perfectly regular. The gauges were correct, and the highest vacuum obtained was 29·5in.

FREDK. CHAS. HASTE, late R.N.
148, Bedford-road, Clapham, December 20th.

SIR,—Being very much interested in the above, and desirous of gaining further knowledge, it was a disappointment when I found Mr. Bremner's disposal of Lupton's pump in so summary a fashion. Whilst admitting that the vertical pump is slightly the more effective, there are many cases in which the horizontal pump is best and cheapest. Mr. Bremner's comparison of the two pumps implies that Edwards' jet condenser pump, at 200 revolutions per minute, must be a much higher-speeded pump than Lupton's pump at 90 revolutions per minute; but in all probability Lupton's pump will run at double, or even treble, the speed of Edwards' pump in actual feet travelled by the bucket, and I very much doubt if any other pump would give better results with the same temperature of injection water used. It would be instructive to know what is the length of stroke, number of revolutions, temperature of water, and vacuum obtained from the respective pumps. W. R.

Crosshills *vid* Keighley, December 21st.

LIVE STEAM FEED-WATER HEATERS.

SIR,—In reply to your note to my letter of November 29th, will you allow me to say that the explanation I gave of increased transmission due to flow will apply to water at any temperature in contact with a surface hotter than itself, and that even in the case of water already uniformly heated to boiling point the rate of evaporation will depend on the rate of convection of water to the surface. The experiments quoted in your article of November 25th fully bear out this view. That increased evaporation due to flow is not recognised in the revered text-books would, indeed, be heresy to imagine. My contention was that the explanation of this from the known effect of flowing water in setting up cross streams which impinge on the surface, seems to have received little or no attention in the recent literature of the subject. In fact, it would seem to be not generally understood that the condition laid down in the article quoted of "a violent impingement of the water on the surface" can be fulfilled by producing a high velocity of flow over the surface.

Liverpool, December 6th. T. E. STANTON.

SCREW PROPELLERS.

SIR,—Referring to the article under the above heading in your issue of the 9th inst., I would submit that the reason for the net result of the screw propeller being equal to that of the paddle-wheel lies in the fact that although designed and constructed on widely varying principles, the proportions of diameter, pitch, area, &c., of each, for obtaining a maximum efficiency, are derived from one basis of calculation, viz., the displacement and immersed section of the hull, in relation to the speed required. Both have a similar ratio of slip. The type of engine for driving varies in construction, but the net efficiency in each case is about equal.

Leeds, December 13th. F. HATTERSLEY PICKARD.

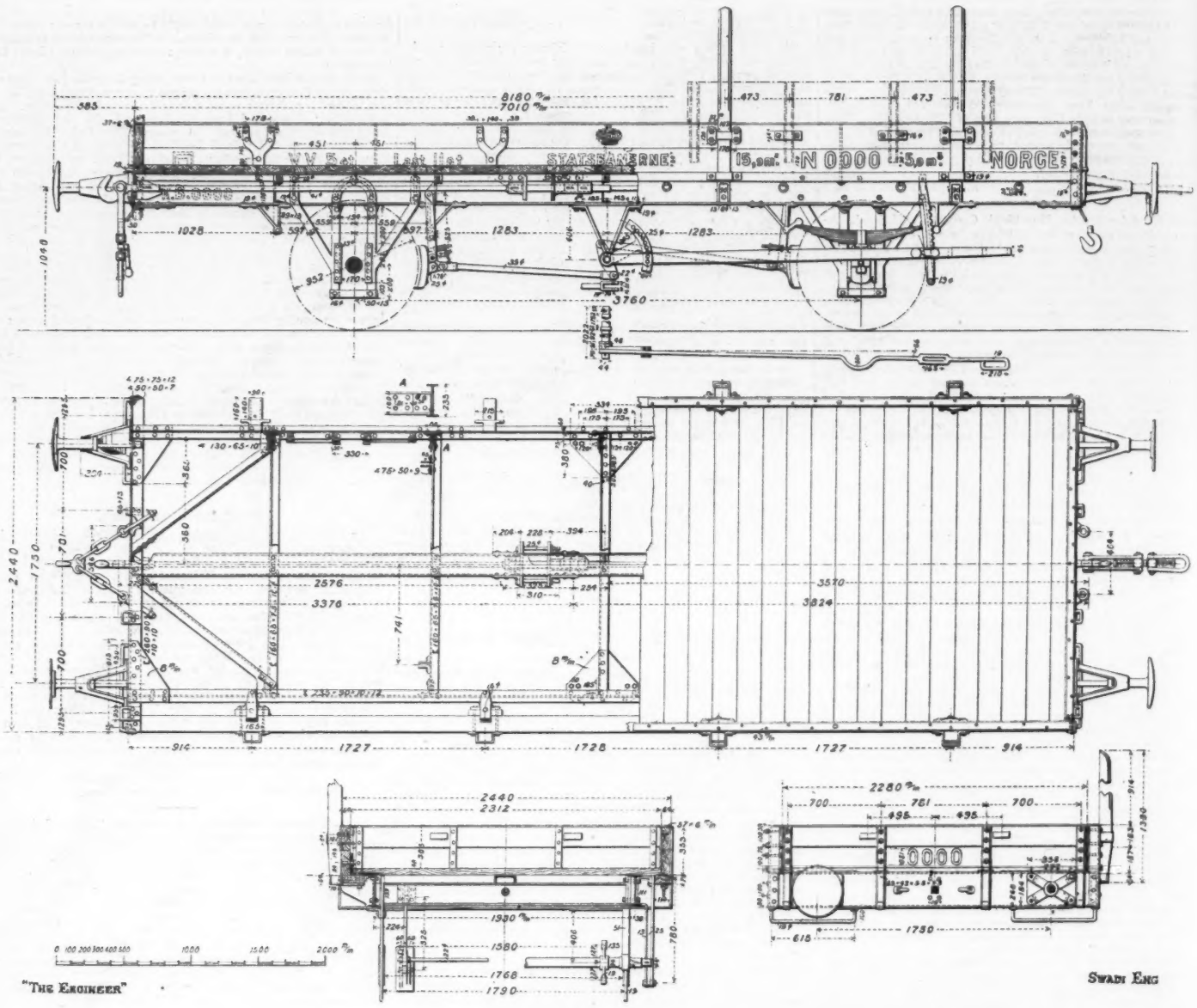
THE STRENGTH OF MORTAR.

SIR,—The literature of cement is very large. We can find full particulars of its strength in a dozen books, pamphlets, and papers, but I fail to get any definite information about lime mortar. Now for every ton of cement used there are at least five tons of lime. We build very high houses and tall chimneys, and rely more or less on the mortar for their stability. Where can I find any recent and useful data on the subject? SIMPLEX.

London, December 20th.

THE Royal Commission on Metropolitan Water Supply have decided to appoint an Assistant Commissioner to render them aid in their inquiry with respect to the estimated costs of the Welsh and Thames schemes which have been laid before them. It is likely that the appointment will be offered to Colonel Rathborne, late R.E.

CONTRACT OPEN—NORWEGIAN TIMBER TRUCK



CONTRACTS OPEN.

NORWEGIAN STATE RAILWAYS.

TENDERS are invited for the supply and delivery in Norway of sixty broad-gauge goods trucks, namely, forty timber trucks, ten ballast trucks, and ten closed goods trucks, in general accordance with regulations dated 6th July, 1896. The accompanying illustration is of the timber truck, or *stake-vogne*. Rolled beams, corner irons, and plates to be of the best Siemens-Martin steel; couplings, buffers, bearings, bolts, nails, &c., to be of Norwegian or Swedish manufacture. A receipt will be given for the proper delivery of tenders. For tenders which are delivered without receipt, no responsibility will be accepted. Tenders offered by telegraph, and telegrams which modify tenders previously sent in, must contain the mark prescribed below, written immediately after the address. Tenders or telegrams affecting the same, which are not marked in the manner prescribed, or not sent in before the expiry of the time allowed, will be put aside. The right is reserved wholly or partly to accept any tender or to reject all. Tenders in sealed envelopes, marked "Godsvogne," should be addressed to Jernhanestyrelsens Expeditionskontor, Christiania, where they should be received by Wednesday, January 4th, 1899.

It may be well to note here that foreign firms are placed at a great disadvantage as regards these Norwegian tenders, as, when a foreign firm offers, it must undertake to do the work from 10 to 15 per cent. lower than any Norwegian firm which may happen to be competing; otherwise preference will be given to native manufacture. This applies, however, only to tenders for goods which native manufacturers are capable of competing for.

THE CORK ELECTRIC TRAMWAYS AND LIGHTING INSTALLATION.

WE have been furnished with details of the electric installation at Cork, which has recently been erected by the Cork Electric Tramways and Lighting Company, Limited. This company has certainly set itself a vast feat to perform, and it will be interesting to watch the result. In a pamphlet circulated among possible consumers we read "that lamps used in sitting-rooms, halls, passages, and kitchens, which usually require lighting between dusk and 10 or 11 p.m. throughout the year, can be supplied at the average rate of 2¾d. per unit," and that "for basements and other dark corners requiring artificial light regularly throughout the whole day, electricity is obtainable in Cork at the extremely low rate of 1½d. per unit," and that "it has now become extravagant not to at once replace the older forms of light in such situations by electric lamps, as the saving in the cost of the light will be sufficient to pay for the entire cost of the change in less than a year." Further than this, a table is given contrasting the difference in cost between using electricity and gas at 3s. 4d. per 1000 cubic feet, the price charged in Cork. From this table it appears that, according to the company, there is a saving all along the line from 8-candle power lights in shop windows, where the lamps are only alight for two hours per day, and the saving is 7d. per lamp per annum, to where the same sized lamp is burning continuously all the year through, where the saving over gas is £4 7s. 6d., and this saving, after renewal of lamps is taken into account. The charges will be made by the Brighton maximum system—the first two hours being charged at 5d. per unit, and the remainder at 1d. per unit.

The figures speak for themselves. Naturally there must be something more than appears on the surface. The company, in addition to lighting, intends to run the tramways electrically, and also to supply power at 4d. for the first two hours and 1d. afterwards. The station is situated in Albert-street, and is built of brick, piles being used for the foundations. The chimney stack is of steel.

The plant consists of three Babcock and Wilcox boilers, each 2531 square feet heating surface, capable of evaporating 8000 lb. of water per hour, and working at 150 lb. These supply steam to three McIntosh and Seymour side-crank tandem compound condensing engines, running at 135 revolutions per minute, with steam heater between the cylinders. These engines are coupled direct to six-pole 200-kilowatt compound generators, giving 500 volts. The engines are condensing, the water being obtained from the river Lee some 220ft. away. The condensers are of the Wheeler Admiralty type, capable of dealing with 12,000 lb. of steam per hour, and there is the usual accompaniment of feed heater, feed pumps, hotwell, filters, &c. There is a battery of accumulators consisting of 256 feeder cells, having a capacity of 770 ampère hours at 110 ampères discharge.

The tram equipment will consist of eighteen top-seat cars, capable of seating forty-four passengers, made by the Brush Electrical Engineering Company, each fitted with two motors with series parallel controllers. The gauge is extremely narrow, only 2ft. 11½in., and the motors have had to be specially designed. The switchboard is provided with the necessary apparatus for lighting and traction work.

The cables, of which over 20 miles have been laid, are made by Messrs. Callenders, and are jute covered, lead sheathed, and tape armoured. Generally they are laid in the ground, but in a portion of their course they have to traverse the river, and here they are laid in a trench excavated in the bed of the river, vulcanised bitumen wire armoured cable being used at this point. The distribution is by the three-wire system, current being supplied for lighting at 230 volts, and for power at 460 volts.

The trams are to be worked on the overhead trolley system, a double track being laid in the principal streets. The tramway crosses the river twice, first over Parnell Bridge—a steel swing bridge—and also over Patrick's Bridge, which is of stone. Special arrangements are made for the trolley wires where they come on the swing bridge. The rails, which in the city are laid on concrete and outside the boundaries on creosoted sleepers, are 83 lb. per yard. The rails are bonded and cross-bonded on the Chicago principle. Centre poles with double bracket arms are used in the principal streets for carrying the trolley wires, and side posts with single arms on the rest of the line.

Enclosed type arc lamps, run five in series, are used for lighting the principal streets, and are placed on alternate trolley wire poles. There will eventually be about 100 lamps.

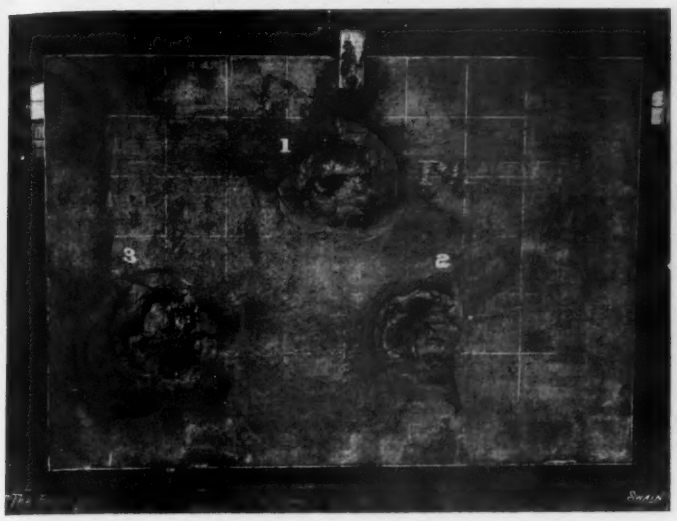
The British Thomson Houston Company, Limited, were the contractors for the work as a whole, and have themselves supplied complete the electrical equipments for the power station.

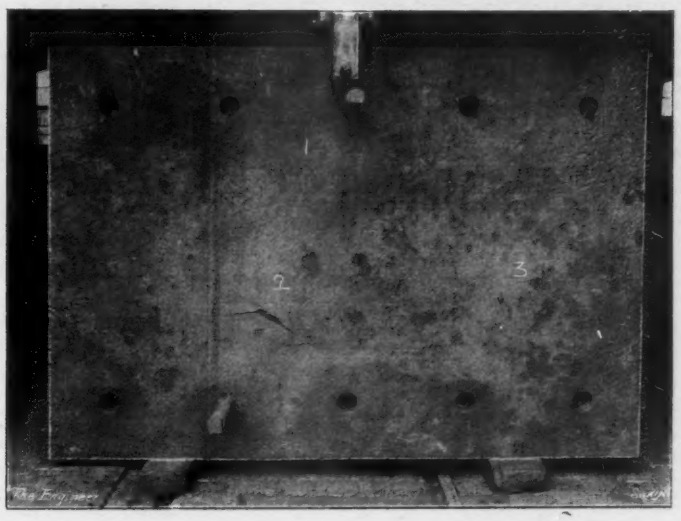
Already nearly the equivalent of 14,447 8-candle power lamps is applied for, and 113-horse power for motor work.

The company will undertake the wiring of premises if this be desired, and certainly it appears to be a most enterprising concern.

SOCIETY OF ENGINEERS.—This Society, which has been established since 1854, held its annual dinner at the Hotel Cecil on Wednesday, December 14th. Mr. W. Worby Beaumont, the President, was in the chair, and the company included Sir Benjamin Baker, Sir John Durston, General Sir Oriel Tanner, Mr. W. H. Preece, Mr. W. H. M. Christie, Astronomer Royal; Mr. Alexander Siemens, Mr. J. W. Swan, President of the Institute of Electrical Engineers; the Hon. C. S. Rolls, Mr. John Aird, M.P., and various past presidents and vice-presidents of the Institution. The occasion was taken advantage of to present an address on vellum and a tea and coffee service to Mr. G. A. Pryce Cuxson, who for the past ten years has filled with zeal and ability the office of secretary. The President, in responding to the toast of "The Society of Engineers," proposed by Mr. A. J. Walter, observed that there were in this country at the present moment more than a million of people who were employed as the result of the great inventions of Stephenson. The Society of Engineers had now been established for forty-five years, and it could not be denied that its successive members had played no unimportant part in the progress of the world. Mr. W. H. Preece, who proposed "Engineering Enterprise," drew attention to the remarkable growth in knowledge, comfort, and pleasure which had resulted from the development of engineering science in the present century. Sir Benjamin Baker replied, and several other toasts were honoured, including that of "The Guests."

MESSRS. BROWN'S 9IN. KRUPP PLATE





COMPLETION OF BROWN'S KRUPP ARMOUR TESTS.

THE introduction of the Krupp process into armour manufacture entailed the tests of plates of three special thickness from all our makers, namely, 6in., 9in., and 12in. approximately. As a matter of fact, the weight of the plate was specified, and not its exact thickness, and this weight per square foot was such that in the case of the heavier plates it necessitated a thickness rather below 9in. and 12in. Thus, as we reported on the occasion of the trial of Vickers', and also Brown's, 12in. plates so called, that the actual thickness was 11¼in., or 11·69in., so Cammell's was 11·66in., which in such a case means the same thing. We now give plates from the official photographs of Brown's 9in. Krupp plate so called, which is actually 8·8in. thick, the area being 10ft. by 7ft., and the weight 11·225 tons. It is a very fine result, but the chief reason for giving it is that we have not given any sample of this thickness. The attack was made on October 27th last with a 9·2in. gun, delivering three Holtzer shot, each weighing 380 lb., on the plate with striking velocities of 1891, 1882, and 1880 foot-seconds, which implies a perforation of 20·8in. of wrought iron, bearing a relation to the thickness of the plate of 2·30. This large factor was completely defeated, as may be seen in the photographs of the face and back of the plate herewith. A few hair cracks may be seen, especially running from No. 2, which appears to have told most, although not the most severe blow, for the bulge at the back is the highest, viz., 2⅜in., and it began to yield in a crack, while the others appear to be sound and free from any sign of yielding. Probably this shot was the best of the three. It may be observed that the calibre of the shot, 9·2, bears an unusually large ratio to the thickness of the plate, and the trial is a very severe one. The striking energy of the first blow was 9423 foot-tons, and consequently the energy per ton of plate was 841·4 foot-tons. Messrs. Brown are to be congratulated on having thus most successfully met the whole of the tests, the 12in., as reported by us, having taken place on July 21st last, and the 6in. the previous year.

NEW "FOOTPRINT" TOOLS.

THE class of tools made by Mr. Thos. R. Ellin, of Sheffield, are well known. They differ from the tools of the ordinary type in being made throughout of thin steel pressed into such shapes as to give the strength in the direction desired. Two new specimens are before us, one of a pair of wire-nippers,

especially intended for cutting off the ends of cycle-wheel spokes, and the other of a soldering bit. They are both illustrated by cuts, which are practically self-explanatory. It will be noticed that the handles of the cutter are of U-shaped cross section, and that the cutting levers are made of pieces of thin steel bent double. The ingenious arrangement by which great cutting power is gained will be at once understood. The working pins are of a

special cast steel. A spring opens the handles, and a leather strap is provided for keeping them closed when desired.

The soldering bit has several points of interest. The shank is again of U-section steel for the exposed part, but the tang which passes right through the handle is bent circular. A number of holes are pierced, as shown, through the shank at its upper end, so that very little heat is actually conducted to the handle. The bit proper is secured by one or two bolts; one is, as a rule, sufficient, and can be bent as shown into various positions; different shaped bits can be fixed for various jobs. It is a convenient, light and handy tool. It is satisfactory to note that both these tools, which we have no doubt will recommend themselves to our readers, are of English manufacture.

ARMOURED PIPES.

A USEFUL armouring for submarine telegraph and telephone cables has been found in a modification of the well-known locked coil wire rope manufactured by Messrs. Felten and Guilleaume, of Mülheim-on-the-Rhine. By making the rope hollow instead of solid, and adapting it as shown in Fig. 1, which illustrates a four-core telephone cable with air spaces formed by paper partitions, and surrounded by gutta-percha and a lead cover to prevent the penetration of water, and locked coil armouring for protection against mechanical injury. In the same manner the locked coil sheathing is used as an armouring for lead pipes suitable for mining purposes, &c.; but in this case it is not only a protection against external pressure, but also renders the pipe more able to resist internal pressure, so that such pipes are especially adapted for the conveyance of water under high pressure, compressed air, &c.

Fig. 1

Fig. 2 is a section of the armoured pipe showing the construction. The lead pipe, which is smooth externally and internally, is first served with impregnated hemp, forming a bed for the locked coil armouring, which is finally served with a double cover of asphalted hemp. The latter is not necessary, but is useful in protecting the locked armouring against destructive elements in water and earth.

Fig. 2

Armoured lead pipes are made by Messrs. Felten and Guilleaume from ¼in. up to 3in. bore, and in any length capable of being transported. Therefore the many joints necessary in ordinary forged and cast iron pipes, which are often the cause of leakage, are entirely dispensed with. The comparatively few joints which should be necessary in long lengths are made by means of the couplings illustrated in Fig. 3. It will be seen at a glance how tightly each half of the joint can be attached to the ends of the pipes, and how easily suitable branch-off pipes and cut-off cocks can be inserted where necessary. The flexibility of the pipes also allows of their being used on undulating ground and in curves where, when forged and cast iron pipes are used, many angle pieces are indispensable, without counting the danger of bursting of pipes and flanges. Also alterations in the installation are much more easily effected with these lead pipes, as they will readily coil on a reel, whereas the ordinary pipes, consisting of short lengths, must be taken to pieces for transport, and re-jointed afterwards.

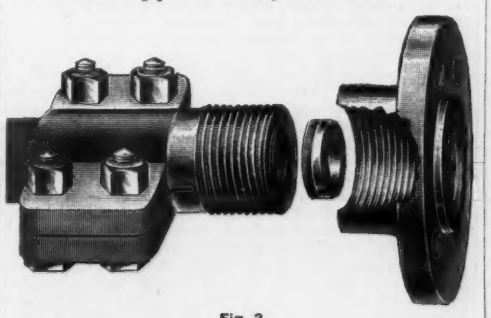


Fig. 3

Armoured lead pipes are already in use for conveying drinking water through rivers, lakes, and seas to ships, lighthouses, islands, &c. For instance, the part of Amsterdam on the other side of the Y is now supplied with water for drinking and industrial purposes by means of three armoured pipes. They have a bore of 2in., a lead cover of $\frac{5}{32}$in. thickness, and a total diameter over the armouring and asphalted hemp covering of 3⅜in. Each pipe as used at Amsterdam is made in a length of 500 yards without joints, and weighs about 10 tons. They were laid 12·4 yards below the Amsterdam water-mark in the bed of the river, a special trench having been dredged out for the purpose. For the laying two lighters towed by a steam launch were employed, fitted with trestles to carry the three reels holding the pipes. As the lighters proceeded, the three pipes uncoiled from the reels simultaneously, and dropped in the deep water of the Y, the whole operation lasting but thirty-five minutes. After laying, the pipes were submitted to a pressure test, which proved them to be absolutely water-tight. In the works the pipes had already been successfully submitted to very severe tests. Messrs. W. F. Dennis and Co., Billiter-street, are the agents in this country for Messrs. Felten and Guilleaume.

THE GAS-LIT BUOYS OF THE CLYDE.

CONSIDERABLE progress has been made of late years in respect to the illumination of buoys, rendering them of much greater utility for night navigation. The Clyde Lighthouses Trustees, who were the first to set the example of employing gas jet buoys—now about nineteen years ago—have for some time past been introducing an innovation in the buoying and lighting of the Clyde and its estuary in fixing occulting or flashing lights on many of the buoys formerly fitted with fixed lights. The buoys at the Gantock Rocks off Dunoon, at Skelmorlie, and at Rosneath points, and many of the buoys on the north side of the river between Greenock and Port Glasgow, have been changed from fixed to flashing lights, and the Trustees have just arranged for the same change being made at Strone Point, where, in place of the present black buoy, they are substituting a new buoy provided with the occulting arrangement, the cost of which will be about £390. The oil gas supply on the Pintsch system, which the Trustees manufacture at their own works at Port Glasgow, and supply to all their buoys and light ships periodically, will in this case be sufficient to last for 180 days and nights—*i.e.*, for six months continuously. Concerning the method of obtaining the occult or flashing effect of these lights, it is not, as is sometimes supposed, by means of clockwork or a perforated revolving screen. The revolving shutter arrangement has been found to be too apt to get out of gear to be satisfactory, and the contrivance in use is the "occulting box," a conical-shaped box about a foot in diameter at the base. The gas, which is at high pressure in the tank attached to the buoys, is reduced to ordinary house pressure by a reducing valve in the lantern. Inside the occulting box is a goatskin diaphragm or drum, which rises and falls with the pressure exerted by the gas. This diaphragm in turn operates upon little iron spindles, which alternately open and close the gas inlets at the required intervals of one, two, or three seconds, as the case may be. The iron casing of the lantern is so constructed that the heaviest sea fails to extinguish the light, this only being possible when the lantern has been entirely submerged for several minutes. The flashes of light from the numerous buoys are varied, so that the mariner may identify the buoy and know exactly his position. In all there are about forty lights, fixed and flashing, to be kept in order between Port Glasgow—where the jurisdiction of the Lighthouses Trust begins—and Garroch Head. At the gas-making works at Port Glasgow the plant in use is capable of producing 4000 cubic feet per day. After being made and purified the gas is allowed to go into the gasholder, from which it is pumped at great pressure into two large tanks. This pressure is the essential feature of the system, as the oil gas can be subjected to a much greater pressure than ordinary coal gas,

a *sine qud non* where the space in the tanks and buoys is so limited. From these tanks the gas is pumped at a pressure of about 170 lb. per square inch on board the storage chambers of the steamer Torch, a specially-equipped vessel, built in 1882 by Messrs. Robert Duncan and Co., Port Glasgow, which visits the different buoys and beacons in turn, according to the holding capacity of the tanks attached, and re-charges them with the illuminant. The gas is put into the buoys under a compression equal to about six atmospheres, or 90 lb. per square inch, and the buoys are necessarily of strong construction, with their joints very perfectly made. The lantern is fixed several feet above the buoy, and is connected with the gasholder by a small pipe, the flow of gas through which is controlled by an automatic regulator, whereby the emission is kept uniform and constant.

DOCKYARD NOTES.

IT appears that the Blake is at last to be put to rights. It must be very nearly two years ago now that reports got about as to the state of her boilers, which were getting worn out, having done more than their share of work. The ship was, however, still employed, though the condition of the boilers made it unwise to use her as the swift cruiser she properly is. There is nothing new in this economy of boilers; our Admiralty are averse to changing them, so long as the necessary precautions only mean a loss of three or four knots. There are a great many ships in service with some of their boilers in the condition "you've got to be gentle with them." There would seem to be some rough-and-ready rule that boilers should last a certain number of years without much, if any, regard as to what has been got out of them in the period. There are, of course, surveys and reports, but when economies are to be effected it is usually at the expense of the boilers. In the French and Russian navies boilers are replaced, perhaps, twice where in ours it would only be done once. There used to be a joke about certain ships that were ordered not to fire their guns except in case of battle, because there was some uncertainty as to how much gun would be left after firing. That joke has lost all, or nearly all, its fitness now-a-days, but there is room for one about ships ordered not to steam full speed, unless capture by the enemy should be otherwise certain. "Victory or steam for full speed" might be the cry. Seriously, however, if the Navy League, instead of busying themselves about the armaments of ships that are never likely to go into action, were to devote a little time to the boiler question, there would be at least less energy wasted.

THE principal sufferers by the mania for making boilers last as long as possible are the makers of the engines. Foreigners desirous of having warships constructed for them are apt to take pretty careful note of the actual performances of ships, without being in a position to know that such and such a boiler or boilers were not made the most of for fear of possible consequences. When a 17-knot ship is known to have struggled along at about 13·5 knots, she soon gets a service reputation of "groggy engines," and the foreigner hears of it sooner or later. The measured mile trip he is not captured by; on what he can get hold of about actual performances he pins his faith. It may, of course, be put forward that the Admiralty know the whole truth, and that they do not build warships for advertising purposes. But the fact remains as one of the many little side incidents whereby the Admiralty help to make things harder for private firms, who, to begin with, they have probably ground down to the last penny. This is all a side issue to the main one. Things are much better than they were, but there is still a good deal of unpleasant unwritten history on the subject of our warships' boilers. They are not renewed when they ought to be if the maximum of efficiency is to be secured.

THE *Daily Graphic* in its naval notes falls out with some recent remarks in this column about the use of electricity on shipboard in the American Navy. The matter is scarcely one that admits of argument. In a nutshell the fact is that it is a great deal easier to work guns by machinery than by hand. An American Board, struck by the beauty of electrical arrangements, suggested their adoption. But the seamen who had to do the fighting, recognising that the experience of Santiago was not a sample of the full stress of battle, put forward more practical views. Every sailor who has studied the matter believes that in the heat of action nothing but hand-power will be of much use, and that making electricity the sole or even the chief agent is a mistake, because the issues on the result are so tremendous that all avoidable risks should be avoided where they can be. Nothing short of a hotly-contested fight will change this opinion, and so, though electricity may become a valuable adjunct, it is never likely to become of prime importance. Hydraulic machinery is open to more or less the same criticisms, but in our service, at any rate, we do not now-a-days rely upon it too much; all the 12in. guns can be worked by hand if need be, everything for turning being ready rigged in the armoured space directly under the barbettes, and the stations allotted. The man who can invent improvements in hand gear has a brighter future than he who relies upon any other motive power. The advantages of being able to do things by hand are being daily more recognised. During the recent war scare, while the Channel Fleet lay alongside the New Mole at Gibraltar the evolution of "shifting billet" by hand was frequently practised. It is, perhaps, only in our Navy that men drag 15,000-ton battleships about; but it is an eventuality that may have to be faced in war time—faced fairly frequently as likely or not; and a good deal of credit is due to Admiral Stephenson for having ordered the performance. There is no question as to whether electrical or any other arrangements will work in peace practice; the question is will they work in a thunderstorm and an earthquake, which two combined would sample pretty fairly a hotly-contested modern fleet action. If there is any doubt upon this head, it is insane to rely upon any motive power for which hand power can be substituted.

THE Yarrow-built Austrian torpedo boats Boa and Cobra met our Channel Fleet at Gibraltar on their way out, and appear to have excited a good deal of admiration on account of their appearance of strength. "More ship and less tin box full of machinery," as one officer put it. The general opinion was that they are eminently practical boats, capable of standing a great deal of knocking about without deterioration, a thing quite as vital as high speed. These boats are of 135 tons displacement—not, therefore, of excessive size as topedo boats go now-a-days.

THE Turks are thinking of sending the Messudujeh, built at Blackwall, and the Assar-i-Tewfik, built at La Seyne, old ironclads, to one of the Italian shipbuilding firms to be modernised. It is a question, however, whether, after the twenty odd years that they have been in Turkish hands, it will be possible to do much with them unless they are treated like the Irishman's gun. Some of the Turkish ships are supposed not to have been in dock for twenty years, or to have worked their engines for nearly as long a period. If it is really true that the ships are going to Genoa, one of the supposed objects of the Kaiser in his recent visit to Turkey—to get the Turkish fleet re-made in Germany—has missed fire. Enough attention was not paid, perhaps, to the problem how a Turkish ironclad was to get through the Bay of Biscay.

WORKS ON THE GREAT WESTERN RAILWAY.

THE year 1898 will remain a memorable one in the annals of the Great Western, for it has witnessed, in the South Wales coal strike, a previously unexampled dislocation of traffic on this line, when the ninety or so coal trains that in ordinary times passed daily through Swindon fell to an uncertain three or four. The Great Western, however, has a staying power which helps it speedily to recover from even so heavy a stroke as this, and during the great strike, while the weekly traffic returns were continually sinking, the great work of relaying the main line from Paddington to Penzance, undertaken before these troubles arose, was carried on with redoubled energy. This famous route to the West has, indeed, been largely remodelled since Brunel completed it, and nearly all the gloomy, cavernous wooden stations of that early railway era have now disappeared, to give place to the now favourite "umbrella" roofed type.

Starting down the line from Paddington this autumn, we notice, first, works in progress at the West London Junction; works which look, at first sight, like the commencement of the new railway to start from this point, and to run thence to Ickenham, Rinslip, and Gerrard's Cross—forming a short route to High Wycombe—a scheme for which the company obtained powers two years ago. The manifest signs of activity here have, however, nothing to do with that project, of which the first sod is not yet cut. The explanation of all these gangs of navvies, and these long lines of tip wagons, being that the company has decided to construct an extensive series of goods and mineral sidings at this, which will, in railway politics, be no doubt an important strategic point in the near future, having regard to the relations now developing between the Great Western and the Great Central, for the interchange of traffic on their systems; and not forgetting the fact that the Great Western is also negotiating with the London and North-Western for what is practically intended to be a joint plan of operations in constructing the Buckinghamshire Railway just mentioned to High Wycombe.

The Great Western has been until quite lately a railway whose resources have been undeveloped. It was not without reason that it was known among the last generation of railway men as "the sleepy giant;" but in these latter days things are very different. For instance, years ago the suburban traffic of the line was a quite negligible quantity, but with the spreading of London westward it has largely developed; although, even so, the Great Western has undoubtedly less traffic of this kind than any other of the great railways of England.

Not the least important feature of the Buckinghamshire Railway—which is also to run through a part of Middlesex—will be that it will open up an entirely new suburban district, as well as affording a shorter route to Oxford than that, *vid* Didcot, now available. Signs of the times worth noting in this connection are the extension of Ealing Broadway Station to double its previous length, now in progress, and the provision of a new wayside station on the main line midway between Slough and Taplow. The full four miles distance between those two stations is a long interval for a district scarcely outside the twenty miles radius from London. This autumn, however, a beginning has been made with a station to be called "Burnham Beeches," which will at once accommodate and develop the summer excursion traffic to that lovely open woodland space, purchased for the delight of the public by the Corporation of the City of London some years ago, and will serve the village of Burnham and its surrounding hamlets, hitherto sadly lacking in railway facilities. The new station will be open in the spring, and will consist of a central island platform, placed between the up and down main line and the up and down relief. It will resemble the present Taplow Station in most respects.

Reading Station, whose rebuilding was mentioned in a previous article in THE ENGINEER, is now practically completed. Further on down the route to the west, the old Chippenham timbered station is at last doomed, and the work of rebuilding has been commenced with the goods yard. After Chippenham comes the great Box Tunnel. New sidings are to be built on the up side of it at Corsham. Both the Box and Middle-hill tunnels have been the scenes of a great deal of work in these two years past. Box has been lined for a great part of its length with brickwork, and Middle-hill entirely so. The bricks used are blue Staffordshire, which seem now to have become universally favoured for railway works. The five miles of line from Box into Bath, perhaps the most architecturally impressive of all these works, have seen some changes of late. Nearing Bath the line runs through more or less shallow cuttings provided by Brunel with very handsome retaining walls from 10ft. to 12ft. in height, built of the soft oolite of the district, known as "Bath stone." These walls have always formed a dignified and impressive feature on approaching Bath. Their profile exhibits a graceful curve, and the stone of which they are built gives an impression of massive solidity, which recent alterations here have found to be quite unwarranted, the stone being quite thin, and the foundations merely shallow footings. At certain places these walls have been replaced with retaining walls of blue brick—not so graceful, but much stronger. In other places the stone has decayed, and has been patched with bricks, variously red and blue.

The new Bath Station has been found a great convenience. Little is to be said about the line further west, works completed a few years ago having brought it up to date as far as Teignmouth. Between Exeter and Teignmouth, however, the wooden viaduct, nearly a quarter of a mile long, crossing the unfathomable mud of Cockwood Creek, has been altered. It was built of timber originally, because it was found practically impossible to get any foundations in for stone piers, and the same cause has determined the alterations completed this year. Instead of rebuilding in stone, truckloads of limestone were brought from the company's quarries near Totnes, and dumped into the mud and water of the creek on either side of the viaduct until an embankment was formed, thus strengthening the old wooden structure.

SMOKE ABATEMENT.

THERE is in Sheffield a Smoke Abatement League, which includes several of its most enterprising citizens, both amongst the professional and manufacturing class. The League was originated through a resolute determination to check the excessive production of smoke in the industrial quarters of the city. A number of prosecutions have been instituted, all against the owners of workshops and factories, the campaign having been aimed at these exclusively, and no attempt made to deal with offenders of the household. The leading spirits of the League have proceeded on the assumption that the smoke nuisance is mainly attributable to two causes—the lack of sufficient boiler power and to careless stoking. The efforts of the smoke reformers have undoubtedly resulted in a cleaner and a clearer atmosphere throughout a city which was greatly in need of vigilant attention, but the fight for pure air has now come to a pass which is somewhat peculiar. Some time ago the Sheffield magistrate had a decision of his against a local firm reversed at Quarter Sessions. The other day, when several cases were brought before him, the magistrate, while expressing the hope, with regard to one of these prosecutions, that there would be no complaint in the future, proceeded to say that in his opinion the result of the appeal in which his decision was reversed took away the power of the Court to deal with these cases. It was contended by the solicitor for the League that because the magistrate's decision was reversed in one case, under a particular set of circumstances, he should not feel justified in refusing an order in another case. To this his Worship replied that he did feel justified, because the latest case resembled the other. The similarity was admitted, whereupon the magistrate declared, "Then they will all go. I cannot go on making orders for appeal." This action of the local Court has naturally discouraged the local gentlemen who are endeavouring to secure cleanlier conditions of living, and it is felt that the cause of reform has been set back by his Worship's action. It is believed, however, that the position he has taken up is not tenable, and that he will have to take the cases that come before him upon their merits. The Smoke Abatement League, which the Medical Officer for the city extols as "a most useful society," will have the support of the public in their demand for the carrying out of the law, even although in a particular instance the decision of the local Court may have been set aside at Quarter Sessions. It has been proved in actual experience that a great deal more smoke is made than is essential for the carrying on of local industries, and, that being so, the law must be put in force so long as those who make the smoke are indifferent to its overproduction.

THE LOCOMOTIVES ACT, 1898.

THE Locomotives Act, 1898, comes into operation on January 1st next. It applies to the whole of England, and will effect some radical changes in the law relating to the licensing and use of traction engines, steam road rollers, and other locomotives in the public streets. In anticipation of the Act coming into force, suggestions have been submitted to the Local Government Board by the officials of the several County Councils of districts adjoining London with reference to the new bye-laws which will have to be made, and the forms of licences and other forms which will have to be used in consequence of the passing of the Act, and it is anticipated that model bye-laws and forms will be issued by the Local Government Board on the subject. The Act provides that the existing bye-laws shall remain in operation until August 2nd, 1899, unless previously repealed or suspended by bye-laws made under the new Act. In this connection it may be mentioned that the London County Council is empowered under Section 1 to grant permission for vehicles drawn or propelled by a locomotive on a highway to carry weights in excess of those stated in Section 4 of the Locomotives Act, 1861; and under Section 3 the County Council is authorised to give consent to more than the three vehicles allowed by the new Act being drawn by a locomotive. It is thought probable that applications under those sections may have to be dealt with in London immediately the Act comes into force, and under Section 14 the County Council can act through its surveyor or other authorised officer. As a result of this the London County Council has just decided to permit the Highways Committee to act on its behalf in relation to all matters under the new Act pending the issue of a further order on the subject, and has also authorised Sir Alexander Binnie, the chief engineer, to deal with all applications made to the Council under Sections 1 and 3, already referred to.

THE SIMPLON TUNNEL.—The Zurich correspondent of the *Times* states that the Italian War-office has sent a military commission, composed of three generals, a colonel and two majors, to study the question of the defence and fortification of the Simplon Tunnel at Domo d'Ossola, the Italian end of the works at present in the course of construction.

NAVAL ENGINEER APPOINTMENTS.—The following appointments have been made at the Admiralty:—Fleet engineers: James H. Gilbert, to the Howe, for Haulbowline Dockyard; Benjamin J. Barnes, to the Resolution; Edward Norrington, to the Victory, for Reserve; Samuel J. Robins, to the Tamar, for Hong Kong Yard; George Elbrow, to the Monarch, for Cape Yard; W. Coleman to the Victory, for the Vengeance; T. J. Haddy, to the Magnificent; J. D. Nicholson, to the President, for service at Woolwich Arsenal; C. Lane, to the Majestic; J. M. C. Bennett, to the Thunderer, for new royal yacht. Staff engineer: William F. Pamphlett, to the Pembroke, for the Astraea. Chief engineers: Thomas R. Reynolds, to the Victory, for the Barham; James T. Willoughby, to the Wildfire, for the Salmon; Charles A. Moore, to the Pembroke, for the Astraea; W. W. H. Rawlingson, to the Hibernia, additional, for Malta Dockyard; F. H. Dart, to the Pembroke, for the Blenheim; R. W. Green, to the President, for service at the works of Messrs. Whitehead and Co.; R. St. J. Raper, to the Victory, for the Scout. Engineers: W. H. Wood, to the Victory, for Portsmouth Dockyard; Alfred Burner, to the Victory, for Portsmouth Drawing-office; Robert B. Dixon, to the President, additional, for service; Alfred Whitmarsh, to the Vivid, for the Orwell; W. A. Dathan, to the Victory, for the Dove. Assistant engineers: George H. Durston, to the Pembroke, for the Grasshopper; A. E. Cock, to the Victory, for the Andromeda; G. Moore, to the Alexandra. Probationary assistant engineers: Frederick C. Fisher and George H. White, to the Magnificent.

RAILWAY MATTERS.

IN consequence of the great pressure of work in all the locomotive engineers' shops throughout this country, and the utter impossibility of obtaining deliveries within a reasonable period, the Midland Railway Company has been compelled to place an order for twenty goods engines and tenders, which are urgently needed, with Philadelphia and New York firms. At the present time the Midland have two hundred engines on order with English firms.

A COLLISION occurred on the Great Eastern Railway on Monday afternoon between Ilford and Manor-park. A local goods train was shunting, when a truck left the metals. A through goods train proceeding to London almost immediately afterwards came into collision with it, and the engine and several trucks were thrown across the metals. Fortunately no one was injured, but the up and down main lines and the up local line were blocked, the permanent way being considerably damaged.

CONSIDERABLE excitement has been caused in Atherstone owing to the receipt of information that the London and North-Western Company, in order to avoid the reduction of speed to four miles an hour, is intending to construct an entirely new railway direct from Nuneaton to Tamworth, to be called "the fast lines." It will be shorter, and have better gradients than the present railway, and will run some distance away from Atherstone. The present railway will then be known as the "slow lines," and as the number of trains will be greatly reduced, there will be no necessity for a bridge for some years to come.

AN interesting memento of the early days of the railway in this country was sold at a well-known London auction-room on Monday. This was Stephenson's plan of the railway from London to Birmingham, scale 4in. to the mile. The survey was commenced in 1830 and finished in 1832, and the actual work of the railway started on June 1st, 1834. The copies of this plan, deposited when powers were applied for, were burnt in the great fire at the House of Commons Private Bills Office in 1834. This plan was for a long time the property of the late Mr. George King, M.I.C.E., and was sold for twenty-six guineas.

TWO weeks ago it was announced that the London County Council had appointed Mr. Young, manager of the Glasgow tramways, to the management of the Metropolitan tramway system, at a salary of £1500 a year. But Mr. Young, after a short visit to London, declined the post, and Mr. Baker, of Nottingham, was next appointed at an annual salary of £1000. It appears, however, that the Council is again meeting with disappointment, as the Nottingham Corporation have declined to release Mr. Baker under six months, when his engagement terminates. In the meantime a special sub-committee of five members of the Council has been appointed to carry on the management of the undertaking.

THE railway traffic of this country is the most heavily taxed in the world of any on a large scale, says *Sell's Commercial Intelligence*. The average ton-mile rate paid to the railway companies in Great Britain is not less than 1½d., while in a large number of cases, where goods are placed in the higher classes, it rises to 2d. or 3d. per ton-mile. This would not be a matter for serious concern were it not that our industrial rivals and competitors have considerably cheaper transportation costs, but when we reflect that the average ton-mile rate in this country is fully a hundred per cent. higher than the average of the United States, and probably 60 per cent. higher than the average of Belgium and Germany, the matter becomes much more a cause for anxiety. Our contemporary makes a strong appeal to traders, colliery proprietors, and owners of wagons, to assist in bringing about this much-needed reform by adopting double-bogey trucks, and by insisting upon the railway companies granting considerable rebates for loads of this kind. The change cannot take place in a day, but a beginning cannot be made too soon.

THE projected Leek and Manifold Valley Light Railway will prove a great factor in the development of a portion of West Derbyshire and East Staffordshire. It will commence at Hulme End, near the village of Hartington, and proceed through the valleys of the rivers Manifold and Hamps to Waterhouses. The route is one of great natural beauty; among the points of interest are Thor's Cave at Wetton, the singular disappearance of the Hamps and Manifold rivers underground, and their reappearance united at the village of Ilam; the Ecton Mines, and the ruins of Throwley Hall. The line will, in short, give access to some of the finest of the scenic glories of Derbyshire, including Dove Dale and Beresford Dale. It will probably be one of the first light railways in the kingdom established on the narrow-gauge principle under the Light Railways Act of 1896, and will possess great commercial value and utility. At Waterhouses there will be a junction with a railway of the ordinary gauge about to be constructed and worked by the North Staffordshire Railway, which will join the Chuvaet Valley line near Leek, the capital of the Staffordshire moorlands.

TWO schemes are again put forward for the construction of a light railway in the Land's End district. They are promoted by practically the same people as produced the schemes which were disapproved by the Light Railway Commissioners in August last, but have undergone considerable modification in the sense suggested by the Commissioners. One of the two is still described as the Land's End, St. Just, and Great Western Junction Light Railway, but the name of the third is altered from the Penzance, Newlyn, and St. Just Light Railway to the Penzance, Newlyn, and West Cornwall Light Railway. Both propose to connect with the Great Western main line, the "Newlyn" line at Marazion, and the "Land's End" line at Ponsandane, which is between Marazion and Penzance. The idea of continuing the line along the promenade at Penzance has been abandoned, and extensions are proposed to meet the wants of parts of the district which in the opinion of the Commissioners were neglected under the former schemes. Over a considerable part of the route the lines follow the same course, and it is believed that either of them would be much more satisfactory than the old plans. The cost is estimated at from £140,000 to £150,000

IT is now an open secret that, as the result of the recent visit of Mr. F. J. S. Hopwood, Assistant Secretary of the Board of Trade, to the United States, the Board is seriously contemplating the promotion of an Act of Parliament, similar to the law lately passed in America, to make the use of automatic couplers compulsory on the railways of the United Kingdom, says *Transport*. The possibility of such legislation is a very serious matter for our railway companies, involving as it may, in the estimate of one general manager, an expenditure of no less than £7,000,000 of money in re-fitting the existing rolling stock, besides having a most important bearing upon the safety both of employés and passengers, and *Transport* has recently interviewed half a dozen of the most responsible of our railwaymen—four of them general managers and the other two directors—with the object of ascertaining their views on the situation. One of those interviewed—an ex-manager, now a director—expressed himself in favour, notwithstanding the cost to the companies, of legislative action by the Board of Trade on the lines above indicated, but the other five pronounced against such legislation in more or less strong terms. As the result of its inquiries, our contemporary has no doubt that a Bill to empower the Board of Trade to enforce the adoption of automatic couplings on our lines, within a stated period, would meet with strenuous opposition from the railway companies; but, on the other hand, the railway authorities display every disposition to support the Board in pursuing its investigations into the subject, and, if a proposal is made by the Board to hold a public inquiry into the relative merits of the coupling systems of England and America, it will, *Transport* thinks, meet with hearty support on all hands.

NOTES AND MEMORANDA.

THE United States Ordnance Department has recently adopted maganese steel exclusively for gun carriage shields in place of nickel steel.

IT was stated at the offices of the East London Waterworks Company, on Monday, that the constant service of water had now been put into force throughout the whole district supplied by the company.

AT the meeting of the London County Council held this week the Parliamentary Committee was authorised to seek powers in the next session of Pailiament to enable electrical traction to be used on all or any of its tramways.

THE coal consumed in making scrap iron car axles at the Southern Pacific Railroad shops, as stated by Mr. D. Uren, before the Master Blacksmiths' Association, is 0·46 of a pound—bituminous—per pound of iron heated. The scrap is heated in four piles of 600lb. each. These are roughed down the full length under the steam hammer, after which one-half of the axle is heated and finished, and then the other half is treated likewise, three heats being required. The work is claimed to be improved enough by the heating to justify it.

THE treatment of steel in the shop is important, and steel has been condemned because of mistakes in handling it in the machines. In one case, says the *American Engineer*, a failure resulted from too high a speed in the lathe, which on examination was found to be over 20ft. per minute for the finishing cut, when the best practice with extra heavy lathes on the same material is 19ft. per minute for the roughing cut, and from 14ft. to 16ft. on the finishing cut. Often the best economy is found not in using the maximum speed, but in sacrificing speed in order to maintain a heavy cut which heats the tool less. It seems in many cases to be good practice to work hard and slow. The desired end is to remove the maximum amount of metal in a given time, and this may be better done on a strong, stiff machine by a heavy cut and rapid feed and low-cutting speed than by light fast cutting.

IN giving evidence before Lord Llandaff's Commission on the London Water Supply, Mr. C. Hawksley, M.Inst.C.E., handed in a table which showed that the population of Greater London was estimated to grow from 5,656,909 in 1891, to 13,043,712 in 1941. The population of Greater London now actually supplied was 5,703,401. In considering future requirements he had taken 55 gallons per head as a safe basis. The table gave as the average daily supply in 1897, 202,102,544 gallons. Of that quantity there came from the river Thames 112,178,641 gallons, from the Lea 55,292,863 gallons, from springs and wells 34,488,016 gallons, from ponds at Hampstead and Highgate 143,024 gallons. The real object of the table was to give the estimated quantity of water required in 1901, and every ten years up to 1841. Lord Llandaff said that to meet the requirements Lord Balfour's Commission reckoned upon 52½ million gallons per day from the Lea, 40 million gallons a day from wells in the Lea Valley, and 27½ million gallons from wells in the Kent district, making a total of 120 million gallons a day.

LARGE quantities of electrical machinery are now being made at Pittsburgh for buyers in this country, according to the *Consular Journal*. The chief producer is the Westinghouse Electric Company, who have in hand contracts to supply the Hull Tramway Company with apparatus for ninety-two electric railway motors, to equip forty-five cars, and one track sweeper. Besides this, the company named have also to supply the Halifax Tramway Corporation twelve motors, to equip six cars; for the Bradford Tramway Company forty-eight motors, to equip twenty-four cars; for the city of Norwich eighty motors, to equip forty electric cars, and four electric generators, to be installed in the power-house of the Norwich Tramway Corporation, to generate the electric current for the operation of these cars; for the city of Coventry twenty motors, to equip ten cars, and two power generators; and for Plymouth ten motors and two power generators are being manufactured for the operation of the local tramways. This makes a total of 262 electric railway motors and eight generators now under construction for England.

THE London County Council invites designs for a dust cart for use in connection with the collection and disposal of house refuse. It is required that the cart shall be so constructed and furnished with such a covering as to prevent the escape of any refuse from the cart and also to prevent any nuisance arising from any offensive refuse which may be carried in the cart. The designs will be judged by Captain Sir Douglas Galton, K.C.B., F.R.S., the chairman of the Council of the Sanitary Institute. A premium of £25 will be paid to the competitor whose design is adjudged to be the best, unless Sir Douglas Galton shall determine that no design sent in is sufficiently good to merit such premium, in which case the Council reserves the right to withhold payment of the premium. Full details and any drawings, or other particulars necessary for a complete explanation of the design, should be sent in a sealed cover addressed to the Clerk, London County Council, Spring-gardens, S.W., and endorsed on the left-hand corner of the cover, "Dust Cart and Cover," and should be delivered not later than 10 o'clock on Tuesday, the 28th day of February, 1899.

IN a paper recently read before the Engineers' Society of Western Pennsylvania, the author Dr. R. Moldenke, gave some particulars relating to the melting point of cast iron from observations he had made. A set of fifty-seven pig and cast irons, with but few exceptions, had no abnormally large variations from ordinary standards, but the range of silicons from ·14 up to 3·29 per cent., with their corresponding variations in combined and graphitic carbons, were admirably adapted to bring out the influence of the former to lower the melting point. The two extremes only are given herewith; a white iron which melted at 1990 deg. Fah. having 4·20 per cent. combined carbon, and a grey one going at 2280 deg. Fah., or 290 deg. higher, contained only ·13, the balance of the 3·56 per cent. total carbon being graphite. To properly determine the influence of phosphorus, manganese, and sulphur on the melting point, it would be well to take an iron which remains perfectly white at all casting temperatures, and add to it different proportions of these elements while it is in a melted state, casting each resulting mixture at once. In this way all the carbon remaining combined, a good comparison would be obtainable.

AN instructive paper was read at the late meeting of the American Society of Mechanical Engineers by Mr. C. H. Benjamin, on "The Bursting of Small Cast Iron Fly-wheels." The author arrives at the following conclusions:—(1) Fly-wheels with solid rims, of the proportions usual among engine builders, and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100ft. per second, if the iron is of good quality and there are no serious cooling strains. In such wheels the bending due to centrifugal force is slight, and may safely be disregarded; (2) Rim joints midway between the arms are a serious defect, and reduce the factor of safety very materially. Such joints are as serious mistakes in design as would be a joint in the middle of a girder under a heavy load; (3) Joints made in the ordinary manner with internal flanges and bolts are probably the worst that could be devised for this purpose. Under the most favourable circumstances they have only about one-fourth the strength of the solid rim, and are particularly weak against bending. In several joints of this character on large fly-wheels, calculation has shown a strength less than one-fifth that of the rim. Several important American engine builders are said to have changed the design of their wheels lately by bringing the rim joints opposite the ends of the arms.

MISCELLANEA.

THE Assistant Director of Government Dockyards, Mr. Marshall, has recently visited Pembroke Dockyard, and inspected her Majesty's new yacht, which is now being built there, and upon which a very large number of artificers are at present engaged, preparing her for the launch, which will take place in about four months' time.

A CONTRACT for 15,000 electrical horse-power has been made between the Union Carbide Company and the Niagara Power Company, the power to be delivered some time next summer. This power is the product of three of the big dynamos in the great Niagara Central station. The existing works of the Carbide Company will be continued, but in order to utilise the additional amount of power immense new works will be constructed at once.

ON and after Christmas Day the postage to be prepaid on letters from this country for India and the under-mentioned British Colonies and protectorates will be 1d. per ½oz., instead of 2½d. as at present:—Aden, Ascension, Bahamas, Barbadoes, Bermuda, British Central Africa, British East Africa, British Guiana, British Honduras, Canada, Ceylon, Cyprus, Falkland Islands, Fiji Islands, Gambia, Gibraltar, Gold Coast Colony, Hongkong, India, Johore, Lagos, Leeward Islands, Malay States, Natal, Newfoundland, Niger Coast Protectorate, Niger Territory, St. Helena, Sarawak, Seychelles, Sierra Leone, Straits Settlements, Tobago, Trinidad, Turks Islands, Uganda, Windward Islands.

THE demolition of the houses on the western side of Parliament-street, Westminster, which has been proceeding for some months, is now nearly complete. So far have the operations for the purpose of widening the thoroughfare leading from the Local Government Board offices on the north side of Charles-street to the Houses of Parliament proceeded, that the formation of the site into a carriage-way has been commenced. The new roadway will be made and paved with wood before the meeting of Parliament. Already the effect of the improvement can be gauged. An uninterrupted view of Westminster Abbey can now be had from Whitehall, and Parliament-square, lying to the north of the Abbey, can now be seen to advantage.

THREE of the Spanish ships sunk at Manila are to be raised by a Hongkong firm of wreckers and put in thorough repair for 500,000 dols., according to a contract just made by Admiral Dewey. These ships are large gunboats; two, the Isla de Cuba and the Isla de Luzon, are 200ft. long, 30ft. beam, and 11½ft. draught, with a displacement of 1040 tons each. They are built of steel, have twin screws, a good protective deck, and a battery of six 4·7in. Hontoria guns, four 6-pounders, two 1-pounders, two Nordenfeldt guns, and three torpedo tubes. The speed is 15·8 knots under forced draught. The other, the Don Juan de Austria, is 210ft. long, 32ft. beam, 12½ft draught, and 1152 tons displacement. She was built at Carthagena in 1887, and her armament includes four 4·7in Hontoria guns, four 6-pounders, one machine gun, and two torpedo tubes.

THE French Superior Council of the Navy, which is the nearest approach France possesses to an Admiralty Board, has been reconstituted. Formerly among its members were included the naval prefects and the commanding officers of the Mediterranean and Channel Squadrons, but in 1886, on the ground of the inexpediency of calling these officers from their important posts all at once to meetings in Paris, which, however, took place rarely, they were excluded from the council. According to the *Army and Navy Gazette*, the older arrangement has now been reverted to, and the council will henceforth be composed of the Minister as president, the vice-admirals on the active list who have been in command of squadrons, the admirals commanding in the Mediterranean and Channel, the naval prefects, and the chief of the staff, the sub-chief having consultative voice.

THE first pile of the Admiralty Pier extension, forming the western arm of the National Harbour at Dover, was driven on Wednesday, those present including the representative of the Admiralty, Mr. Wilson, Mr. Maurice Lee, Mr. Thompson, resident engineer to the Admiralty, and Mr. Mayo, representing Messrs. Pearson and Son, the contractors. The piles that are being used are the largest employed in any marine work in the kingdom, being 105ft. long and 20in. square. All the requisite machinery for lengthening the pier is in position on top of the turret which contains the 80-ton guns. A very powerful crane, specially constructed for the purpose, is being used in connection with the pile-driving. The works at Eastcliffe, where the Marine Railway and reclamation wall are being constructed, are proceeding rapidly, and at the works on the shore, near Shakespeare Cliff, good progress is being made.

THE report by Sir William Crookes, F.R.S., and Professor Dewar, F.R.S., on the composition and quality of daily samples of the water supplied to London for the month ending November 30th gives the results of their analyses of the 182 samples of water collected by them during the month from the mains of the London water companies taking their supply from the Thames and Lea. Of the 182 samples one was found to be "slightly turbid;" the remainder were all clear, bright, and well filtered. The rainfall at Oxford during November has again shown a deficiency; the actual fall was 1·86in. The average fall for the past thirty years is 2·42in.; this leaves a deficiency of 0·56in., and makes the total deficiency for the year 6·67in., or 28·2 per cent. The bacteriological results for the month were satisfactory. The East London water supply was exceptionally good, the average of 26 samples being only 11 microbes per c.c., whereas the mean of 123 samples from the Thames-supplied companies was 49 per c.c. The report adds:—"Both these results prove highly efficient filtration; but it must be confessed that a reduction of a number of microbes to anything as low as ten or eleven is highly exceptional, and more than could have been expected a few years ago, when between 100 and 200 microbes per cubic centimetre were considered allowable in a potable water."

THE old adage that necessity is the mother of invention has just been illustrated in Sydney, where the long-vexed problem of remuneratively navigating the shallow inland streams of New Zealand has been solved, says the *Syrex*, by the construction of a peculiarly-shaped vessel, the first of its kind seen in Australasia, having a speed of 11 knots, and drawing only 6ft. 6in. when fully loaded. The new vessel is an adoption of those characteristic of the gun and other boats on the Nile, and also the shallow waters in India. In the vessel, which has been successfully launched in the New South Wales metropolis, the stern takes the shape of a long, gradually rising tunnel, highest immediately over the propeller, thence gently sloping towards the load water mark at the extreme after end. This tunnel is in the shape of a half cylinder, the edges being always under water, the interior top of the arc being a foot above water when the vessel is fully loaded. The propeller runs through the centre of this semi-cylinder, and when the boat is stationary, the top of the screw is some little way out of the water. As soon as the engines are started the air in the semi-cylinder is expelled and replaced by water, in which the propeller works as efficiently as in vessels of heavier draught. The loss of efficiency in light craft is mainly occasioned by the propeller taking down air, which is prevented in the tunnel-like arrangement of the new vessel. The Aotea, as the vessel is named, has a length of 126ft. 6in., with 24ft. 7in. beam, and 13ft. 3in. depth of hold. She is provided with all the requirements of a first-class intercolonial steamer. The deck, which is unbroken, forms a broad promenade, giving a walk of 100ft. clear of everything. In addition to coal, water, machinery, and other deadweights, over 50 tons of cargo can be shipped.

THE ILLINOIS STEEL COMPANY'S WORKS, SOUTH CHICAGO, U.S.A.

(*For description see page 603*)

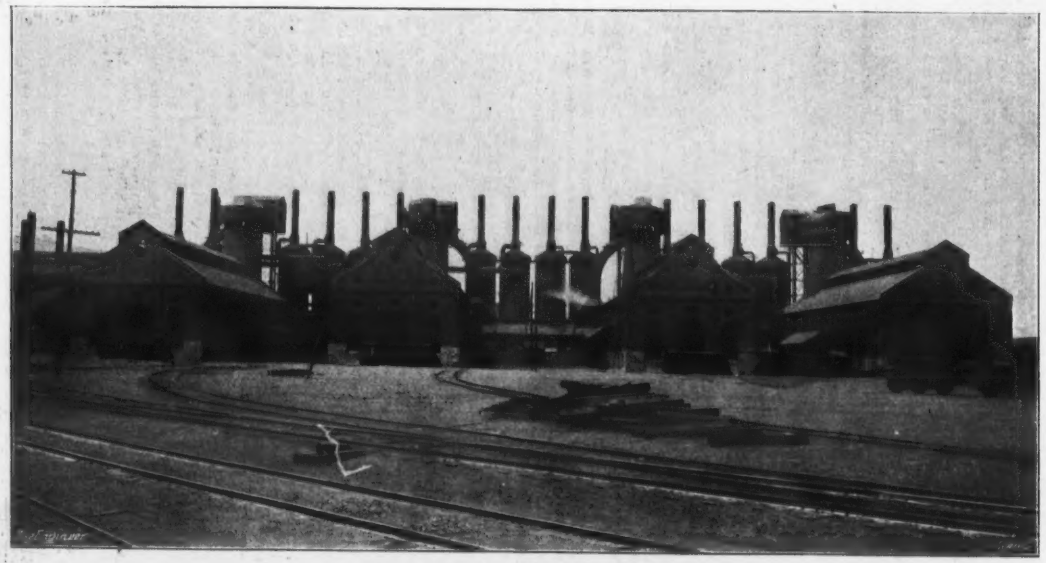


Fig. 2—BLAST FURNACES, Nos. 5 to 8

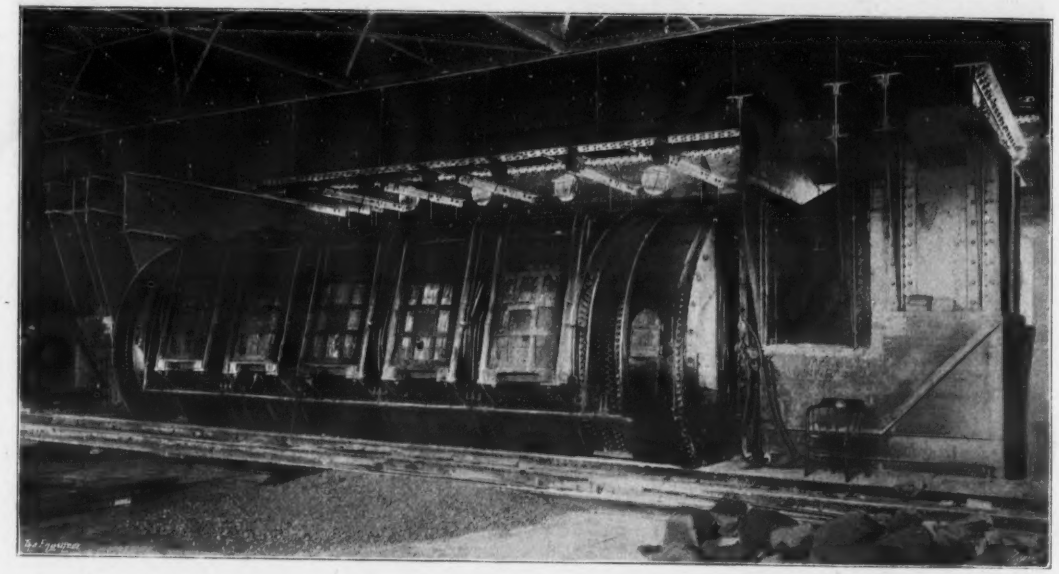


Fig. 4—CYLINDRICAL MIXER—FRONT

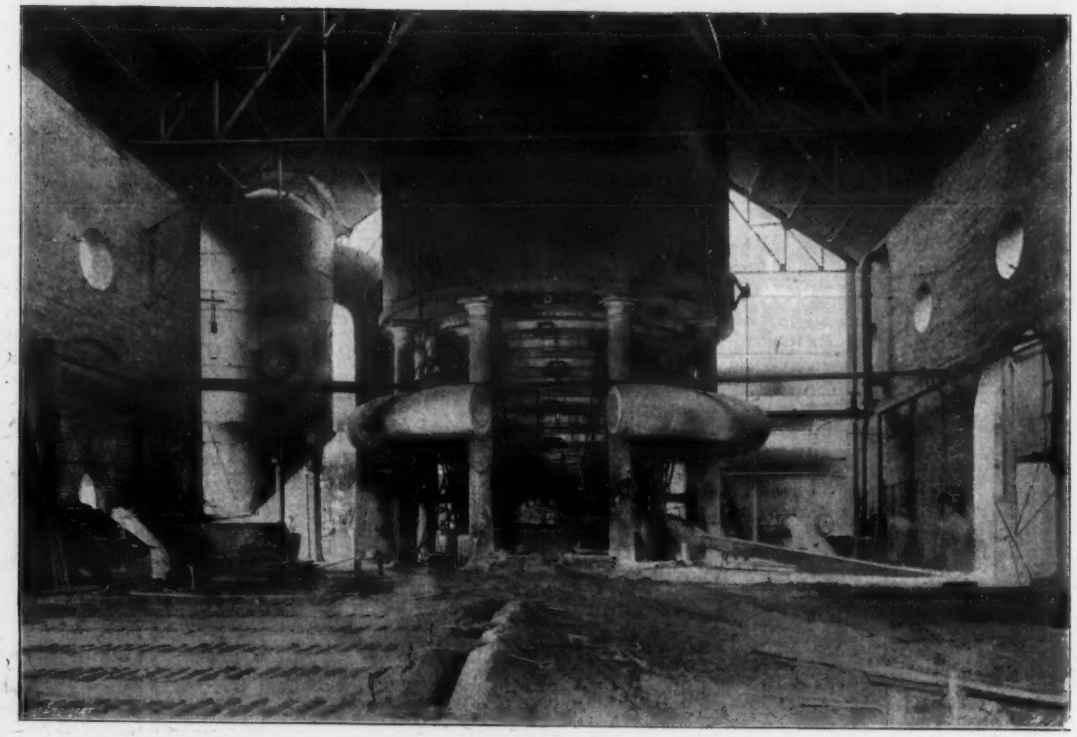


Fig. 3—FURNACE No. 5 AND DUST CHAMBER

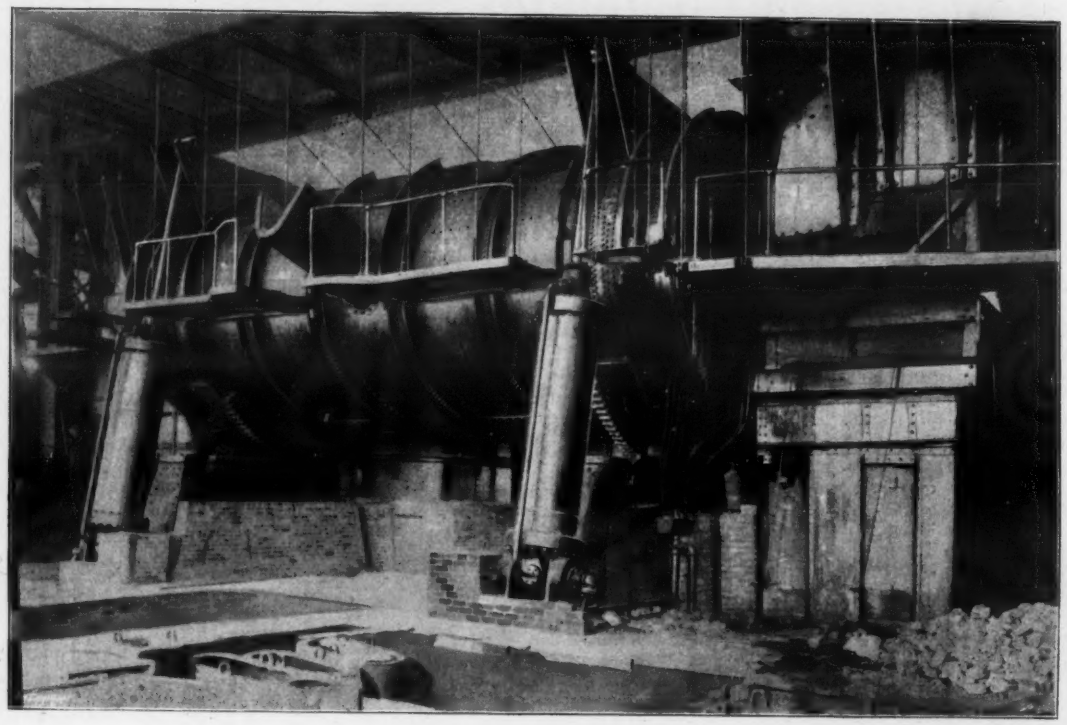


Fig. 5—CYLINDRICAL MIXER—BACK

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

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*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

REPLIES.

A. D.—Without seeing the armature and its dynamo it is impossible to say in which direction the former should be driven. Most probably, however, the proper direction would be so that the centrifugal force would tend to tighten the end connections, or, as shown in your drawing, in the same direction as the hands of a clock. The lead of the brushes will depend upon the position and shape of the fields. The best position can easily be found by trial.

W. (Richmond Hill).—To give you any information just now with regard to the gauges of railways in China would be premature and possibly misleading. Chinese politics just now are very kaleidoscopic, and the eventual railway gauges will depend upon these politics. There is no such thing as a standard gauge in China at the present day, and with England, Russia, Germany, France, America, and Belgium, all claiming and obtaining more or less authenticated railway concessions in China, the eventual standard gauge cannot at present be foretold. If you wish for trustworthy information on the subject of Chinese railways, we would refer you to our issues of March 18th and May 20th of this year.

MEETING NEXT WEEK.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, Thursday, and Saturday, December 27th, 29th and 31st, at 3 p.m., Afternoon Lectures on "Astronomy," by Sir Robert Stawell Ball, D.Sc., LL.D., F.R.S.

THE ENGINEER.

DECEMBER 23, 1898.

TRAIN RESISTANCE.

THE vexed question of train resistance still attracts and deserves attention. We may remind our readers that the latest contribution to the growing literature of the subject was the paper by Mr. Smith, read at the last meeting of the Institution of Mechanical Engineers, reproduced and criticised in our columns. We are, through the courtesy of Mr. McIntosh and his assistant Mr. Weir, able this week to place before our readers a series of diagrams which teach a lesson in a way that cannot be disputed. These diagrams are a selection from some hundreds of diagrams, which form a record from minute to minute of the work done by a powerful engine in hauling a heavy and fast train on the Caledonian Railway on a run from Glasgow to Carlisle. We do not think that a similar record has ever been taken. With the chart of combined results on page 624 we shall not now concern ourselves, we shall confine our attention to the indicator diagrams, and to these only. They show what was going on in the cylinders of the locomotive at various speeds. We have perforce had to make a selection; they are typical of all the rest. If we filled page after page with these diagrams, they would be found in no way to modify or alter the lesson taught by the thirty-one diagrams which we publish.

Let us now consider what they prove. In the first place, the average pressure represents *pari passu* the average tractive effort; that is to say, as the average pressure rose so did the tractive effort of the driving wheels on the rails, and as it fell so did the tractive effort decrease, always at the same rate. It will be seen at a glance that the tractive effort invariably diminished as the speed increased. Now, there are various ways in which the problem of tractive effort and train resistance may be regarded. Thus, we may consider it from a purely theoretical point, and say that, other things being equal, the resistance of a train augments with the speed in some definite or indefinite way. Or, again, it may be said that all the variations in tractive effort are due to gain or loss of momentum in the train, brought about by constant changes of speed. Our contention hitherto has been, that all the available evidence of diagrams goes to show that the resistance of a train, instead of being augmented with the speed, is reduced. That is to say, there is some moderate velocity at which the resistance is greater than at any other speed, higher or lower. We have, however, favoured for some time a modification of this proposition. Hitherto we have not put it forward for lack of evidence; that is now supplied by the Caledonian diagrams; and we no longer hesitate to say that, be the cause or causes what they may, it is certain that in daily work the tractive effort required to haul a train diminishes as the speed augments. This is a variant, and a variant of importance on our first proposition. That would mean that on a perfectly straight and level railway the resistance of the train would decrease as the speed rose. We are not in a position to prove this, because we have not a sufficient number of diagrams taken under the stated conditions. The new, or second proposition, amounts to the assertion that in practice the tractive effort required to haul a train diminishes as the speed increases. This is not at all the same proposition in different words as that which preceded it. It takes no cognisance whatever of train resistance; but it does state a fact of the greatest possible importance to railway companies. To them train resistance is quite a secondary matter. It is well to make our meaning quite clear, even at the risk of being prolix. The received belief is that the resistance of a train is fairly expressed by D. K. Clark's formula $R = 8 + \frac{v^2}{171}$, or some other such cognate equation. This may or may not be true. It has no application in practice. If we take real trains hauled by real locomotives on real railways, the tractive effort of the engine at the rails does not agree with the formula, or anything like it. Instead of the tractive effort rising with the speed, it decreases. Inclines come in to help the engine. The train resistance may augment or it may not. So far as the locomotive is concerned, gravity is always coming into play and helping or opposing it. The actual tractive effort that must be put forth by the locomotive is the factor of interest. The pulling effort of the engine must be proportioned to the weight of the train, and has nothing to do with the speed. Given a train of 200 tons, and an engine with cylinders 18in. by 24in., and 7ft. drivers, that engine will haul that train from point to point on any average railway just as well at 70 miles an hour as at 20 miles an hour, always provided the boiler is big enough. The reason is simply that the high speeds are only reached as the result of running down hill. This is practice, and it is only with the actual running of trains that we are for the moment concerned.

Let us turn now to the proofs which we are able to adduce of the truths of our second proposition. They are supplied by the diagrams on page 625. Take the first and the last diagrams. We have an average pressure of 77 lb. and 30½ miles an hour, and 21·25 lb. and 62 miles an hour. Take the four diagrams along the top of the page, and we find 77 lb. and 30½ miles, 77·75 lb. and 29½ miles, 80·25 lb. and 29 miles, 77·25 lb. and 29 miles, and 79·5 lb. and 28 miles per hour. Take now the bottom row all across and we have 68 75 lb. and 39 miles, 66 lb. and 41 miles, 60 lb. and 43 miles, 20 lb. and 63 miles, and 21·25 lb. and 62 miles an hour. All the cards tell the same story, viz., that the average pressure fell off with the speeds, and that the speeds depended on the inclines. The slight irregularities and discrepancies are due, no doubt, to changes of velocity. It must be remembered that these cards were regularly taken at intervals of one minute, and it is noteworthy that they do not show any very violent changes due to the rise and fall of momentum. Another point claiming notice is the small variation in the power developed by the engine. The greatest power shown by any of the cards we have selected was 907, the train running at 55 miles per hour, with 51·25 lb. average cylinder pressure. The least, if we leave out those taken when the train was tearing down hill, was 712, a maximum difference of but 195-horse power. It we reject these extremes, it will be seen that the power was wonderfully uniform between 700 and 800-horse power. It is not possible, we think, for any one with those diagrams before him to maintain that the tractive effort required to haul a train from Glasgow to Carlisle increases enormously, or indeed, increases at all with the speed. We do not think we shall be far wrong if we say that the boiler of Mr. McIntosh's locomotive could regularly make steam for about 800-horse power. That was about the best average, and a very high average it is, representing an evaporation of about 17,500 lb. of water per hour. For a heating surface of 1400 square feet the rate of evaporation must be 12·5 lb. of water per foot per hour, and for a 21ft. grate and 7 lb. of water per pound of coal, the rate of combustion was about 120 lb. per square foot per hour. This is, so far as we are aware, the maximum sustained effort of any British locomotive. We do not say that it has not been beaten, but only that we have not met with any evidence that it has been beaten. The engine indicated for short periods, it is true, over 1000-horse power, but this does not affect our conclusions.

At first sight it seems curious that the power exerted should have varied so little, no matter what the speed at which the train ran. The relation which this bears to the coal consumption is a little remarkable. Let us suppose that the engine burned 3 lb. of coal per horse-power per hour, and that the train ran for one hour at 30 miles an hour, the power being 700 horses; we have then 2100 lb. of coal burned, and 70 lb. per mile. If, now, the speed is doubled, the power remaining the same, the consumption of fuel falls at once to 35 lb. per mile. All this is quite consistent with practice, but it would assuredly not be consistent if the train resistance augmented with the speed in the way we have so long been taught.

In truth, the locomotive and the train and the road are parts of a complete machine, which act and react on each other, and it is a great mistake to treat any one portion of the machine without regard to the other parts. Locomotive engines and railway companies have little or nothing, as we have said, to do with abstract questions of train resistance. What they have to consider is the effect of speed on the power required, and the consumption of fuel. The experiments carried out on the Caledonian Railway by Mr. McIntosh are distinctly reassuring; they show that the road is a prime factor in obtaining speed. With heavy trains there is no fast running except down hill. At the same time it must be taken as proved that no matter what a tractometer between the tender and the train may indicate, the tractive effort to be exerted by the engine does not augment in any rapid ratio, if it augments at all, with the velocity. The maximum effort on a long level of an English locomotive appears to be about 50 miles an hour for a 300-ton train, and that seems to meet all the demands likely to be made for some time. Higher speeds are only got when running down hill, moderate inclines being a great help to the engine. Higher average velocities mean lighter trains. The results of the trials on the Caledonian Railway, which we place before our readers this week, seem to be final on this point. It is not possible, we think, to get more out of a locomotive of the normal type running on a British railway, and 50 miles an hour is a most satisfactory datum from which to deduct something as we run up hill, and to which to add something as we run down.

A GREAT TELEGRAPH SCHEME.

SIR SANDFORD FLEMING, the eminent engineer, who has now been so long identified with every branch of engineering progress in Canada, and who has been

specially interested in telegraphic communications in general, and the mooted Pacific cable in particular, has memorialised the English Government, with the object of persuading it to establish a complete system of State-owned and worked cables all round the globe. The advantages to be gained from having an unbroken cable girdle are numerous, and not the least of these would be the fact that our possessions in time of war would be kept directly in touch with one another by what would practically be two sets of cables, so that if one cable were cut by the enemy, the other cable must remain intact; and if care were taken and adequate naval protection given, it would be extremely difficult to cut the cable at all. No doubt, too, such a complete system of cables would be of great importance to the commerce of Great Britain, for the project in question aims at the connection of practically all her Majesty's possessions and coaling stations to the main cable.

The present idea takes the following form:—The cable would start from the Canadian port of Vancouver, and would have three points of appearance above water, namely, at Fanning Island, Fiji, and Norfolk Island, before it arrived at New Zealand and Australia, to which two places branches are to be run from Norfolk Island. Australia would be crossed, and a cable would start from King George's Sound, which, after touching at Cocos Island and Mauritius, would either go to Natal or Capetown. From Cocos Island connection would also be made with Ceylon, Singapore, and Hongkong, and from Mauritius with Seychelles, Aden, and Bombay. From Capetown a cable would be run to St. Helena, Ascension, Barbadoes, and Bermuda. From this place communication would be opened up with Halifax, and then by means of the existing cables throughout Canada, and to England itself. Thus there would be a double system of British-owned cable lines the whole world over, and the route chosen seems to have been very carefully selected. In time to come, no doubt the whole scheme will be carried into effect, if not in exactly this way, at all events in a somewhat similar manner. It is only a question of time. The point to be considered is whether or not the State should carry out and control the work. We most certainly think not.

Of course it would be advantageous to have each complete cable round the world under one management, because of the time saved by messages not having to be transferred from one system to another. The only possible objection which could be urged against such a scheme of running this suggested system of cables, would be that it was unnecessary, and that by means of existing cables telegraphic communication is now possible everywhere wherever civilisation has progressed. The answer to this is very simple. All the world's cables and telegraph lines are not under British control, and in addition to this, for New Zealand to communicate with North America — to use an extreme instance — it is necessary to do so *viâ* Australia, Singapore, Madras, Bombay, Aden, Suez, the Mediterranean, and London. For a single syndicate to lay the requisite new cables and to acquire existing lines would involve a very large outlay of capital, yet we are clearly of opinion that some such proceeding would be the most beneficial to the interests of everyone, in spite of Sir Sandford's staunch advocacy of State control. The cables, if run as he suggests, would be unlike our inland postal lines in that there would be only one of them between each port or point of departure, and it would not be at all an unlikely thing, considering that these points of departure would, if the State owned the cables, be in most instances naval bases, to have Government messages continually blocking the lines. Such an occurrence is by no means so likely to happen in Great Britain itself—if on no other account, at all events because of the larger number of trunk lines.

Government monopolies, as many a State has found before this, are not always all that can be desired. Generally a point is reached beyond which no further progress is made. This point is not infrequently short of perfection. There are not lacking people who assert that if the telegraphs of England had been in the hands of private bodies, the service would be much more efficient than it now is. We consider that when it is a question of such a matter as the quick conveyance of messages over the largest possible area, there should be no monopoly of any kind, State or otherwise. This remark does not so much apply to letter carrying. Here, although the Government is to some slight extent the carrier, yet it is the great railway companies and the steamship lines which form the real means of communication between different points, and the rivalry between them keeps the standard well up. The result is that there is but little to complain of in the mail service. But the whole of England groans under a telephone monopoly which practically constitutes a disgrace to the country. When one looks abroad to such places as Norway and Switzerland, both having enormous natural disadvantages in the way of contour of the country, and when one considers that these countries have a most excellent system of telephony at a mere fraction of what we in England are paying for a vastly inferior service, the utter fallacy of monopolies is brought most prominently forward. We could go on to enlarge upon the subject of State-owned railways and the not unusual condition of these, but it might seem to be beside the question, and we confine ourselves simply to cables. What would happen supposing a private firm were to construct an unbroken connection right round the globe? In a very short period we should have another firm making another—and perhaps, after that, a third. Hence exorbitant rates could not be charged. Sir Sandford's own argument can here be used against him. He instances the reducing of the tariff charges between Australia and London from 9s. 4d. per word to 4s. 9d. per word, simply because the construction of a Pacific cable came up for consideration. This supports our argument entirely. It is competition which prevents extortionate charges, and with the cables under Government control there would be no competition. Probably, too, not more than one complete cable would be laid, and the Government could charge any rate it chose. It is true, no doubt, that to have Government protection is greatly to be desired. For instance, in places where the cables land, not only the cables themselves must be protected but also the men in charge of them and of the instruments, and this in out-of-the-world places might be extremely difficult and expensive for private companies to manage. This, however, is the only way in which we can see that Government can assist with the best possible results to the country. Once let the monopoly become the State's, and there is an end to private enterprise in this direction. It is true that the State could not prevent the laying of a cable, but it could and would prevent the sending of messages unless under a royalty more or less heavy. Perhaps some arrangement might even be made by which, in exchange for a subsidy and adequate protection, Government messages might be permitted to take precedence, within limits, and these limits might be extended in time of war or national calamity, the use of the cables at other times being at the discretion of the owners. In time of war, no doubt, every possible facility would be given to the Government, even if necessary to the exclusive use of the cables, during a portion at all events of the day.

We maintain that from every point of view it would be best for the work to be carried out by private enterprise, and that there would be a profit on the undertaking. It is impossible at present to gauge the advantanges to be obtained by knitting the empire together by a continuous and unbroken bond in the shape of a complete cable uniting all our possessions. The advantages are certain to be most widely felt and far-reaching. Trade would not only be encouraged and rendered more easy between the mother country and her Colonies, but between the Colonies themselves. The time will come when Great Britain will become aged. Little by little she will need to lean more and more upon her children, the Colonies, and should they fail her, her state will be bad indeed. We are encompassed by enemies. We are not self-supporting. We need outside assistance, even for our daily bread. Our Colonies are well able to supply us, and it is for us to join them to us by every possible tie. It is, therefore, indisputable that facilitated communication is practically an absolute necessity, and we trust that private enterprise may be forthcoming, despite rumours to the contrary, and in coming forward be well paid for its trouble.

TRADE UNIONISTS IN COUNCIL.

VERY soon the trade unionists will be once more in council. The Manchester Congress next month promises to be quite as big an affair as usual, and the subjects down for discussion are, some of them, of unprecedented significance. In this connection it may be well to remind the labour leaders of the opportunities which they possess of influencing either for good or ill the course of trade in this country. The President of the Board of Trade struck the right note when, at the close of last week, he told the trade unionist deputation which waited upon him that our past industrial wars were, perhaps, more responsible than any other circumstance for the rapid strides which had been made of late years by the manufacturing export trade of our continental rivals and of America. Mr. Ritchie was well informed in putting it to the trade unionists that the people who had gained by these strikes have not been British masters nor yet British workmen. The advantage has been wholly on the side of these newer manufacturers' countries. Orders have gone in large numbers to our competitors, and it is a truism that when these orders have once gone away from the country they are not quick to return. Whether, as the President of the Board of Trade suggests, a remedy for the present state of things is to be found in the setting up of Conciliation Boards, we do not care here to pronounce, but in view of the Manchester Conference these remarks certainly deserve to be borne in mind. No more weighty question than that of strikes as affecting the prosperity of our trade and commerce can well be imagined. The leading theme to be considered next month is the proposal for the federation of all the trade unions in the kingdom into one common body, with the object of supporting each other and acting in unison in case any section is what the men term "attacked" by the employers. This is a proposal that the men should well approach with the greatest caution. The magnitude of the idea is alone sufficient to demand second thoughts. Much more, however, should the injury certain to be done to the trade of the country in case of a wrong exercise of the enormous power which such a combination would possess should give the delegates pause. The temptation to use such an organisation unfairly would, in the very nature of things, be immense; and once roused, the various units would be difficult to control, even by the strongest of leaders. It is fortunate that the theory of all combinations of the kind is founded on a belief in the existence of certain characteristics of what is known as human nature, which the past history of mankind tells us are never manifested by large bodies of men. Unselfishness and self-denial are only met with in the individual. Few men will see their own children go without food in order to fight the battles of other men.

"THE IRON MAN."

IN the Workington establishment of Messrs. Charles Cammell and Co., Limited, there is a machine called "the dummy." It is an invention for pushing the great steel ingots out of the mould—a work which, at one time, by hand and hammer, took much time and labour. The men have been heard to say that the "dummy" is the hardest worker in the place. There seems to be a similar view taken in the coalfield of what is called the "iron man." The "iron man" is a coal-cutting machine, which has been introduced in part of the Haigh Moor seam at Messrs. Pope and Pearson's, in the West Yorkshire district. The Committee of the Yorkshire Miners' Association (Alltofts No. 1 Branch) have issued a circular for help to fight the "iron man." They declare they are fighting against a big reduction in their wages through the introduction of the coal-cutting machine, "or, what is commonly called the 'iron man,'" which, they add, "is forming the principle of a low tonnage rate for all Haigh Moor seams throughout the district." Failing to agree as to a tonnage rate, the case was referred to arbitration. The umpire awarded the miners 1s. 1½d. per ton, plus 20 per cent. The Committee urge in proof that this award is an unjust one, but the management has in some instances given as much as 10d. per ton "in order to make anything like a wage." "What we want," they add, "is a fair tonnage rate, so that we can live honestly, and not, after a week's work, have to submit to that dishonourable principle of our wages being made up." In short, they claim to be fighting afresh "this great question of a living wage." It is man *versus* machine underground, and there is little doubt that in the issue man will go to the wall. He has found out many inventions, and is continually discovering others, which help the world to do without himself. Amongst the latest is the "iron man," which can get coal at about half the price of the old system by hand and pick.

PICKETTING

IN our impression of February 19th last we had a leading article on this subject, which to some extent was called forth by the then recent decision of Mr. Justice Byrne in Lyons *v.* Wilkins. The learned judge had held that for pickets to beset the house of a workman and the place of business of his employers, although they used no violence, intimidation, or threats, was unlawful, and ought to be restrained. The defendants appealed, and on Tuesday the judges of the Court of Appeal delivered their judgments, which they had taken time to consider. The Court was unanimous in holding that the judge of first instance was right, and the appeal was dismissed with costs. We publish in another place the report of the case, which will well repay perusal. The point of the judgments is easy to see. As Lord Justice Chitty said, "attending at or near the house or place where a person lives, or works, or carries on business, or happens to be, in order merely to obtain or communicate information," is the only attending or watching that the law allows. "Attending in order to *persuade*" is not within the proviso. As the Master of the Rolls said:—"It is all very well to talk about peaceable persuasion and to draw fine lines between persuading and giving information." The learned judge then pithily observed upon the real point in these cases: without the "persuasion" element the pickets are simply dummies. Every one knows that perfectly well, and unless this decision should come to be upset by the House of Lords there can be no doubt that use may be made of it in many cases in the future for the protection of both masters and men.

BROWN KRUPP PLATE FOR JAPAN.

A TRIAL of a Brown Krupp process plate, 8ft. by 8ft. by 8·8in., weighing 10·175 tons, took place at the Elswick Company's range at Ridsdale on December 2nd. It was taken as a sample of supply of armour to the Japanese battleship Asahi. The attack was made with an 8in. gun, firing three Wheeler-Sterling shot of Elswick make, weighing 250 lb. each, with striking velocities of 1859, 1964, and 2039 foot-seconds, implying perforation through wrought iron of 17in., 18·5in., and 19·5in., whose ratios to the thickness of the plate are 1·93, 2·10, and 2·22. The plate bore this severe attack admirably, the projectiles being completely broken up, with, perhaps, 3in. maximum penetration. The back showed bulges of 1¼in. or less in height with no sign of cracking.

LITERATURE.

The Discharge of Electricity through Gases. By J. J. THOMSON. London: Archibald Constable. 1898.

THIS volume is the outcome of four lectures delivered at the University of Princeton, New Jersey, in 1896, but it has been amplified by the addition of some new results, which have been published since that time. In a large measure it is an epitome of all that has been done in the way of investigation of the effect of electricity on gases. The authorities and original investigators are in all cases mentioned, and in most an indication is given where original papers and articles are to be found. On this account alone it would, we feel sure, be favourably received by all persons interested in the subject. It contains, however, in addition, the record of original experiments of Dr. Thomson's own devising, and it is attractively written. We do not mean by this that it is "popular" science; far from it, it is science for the scientist, not for the man in the street. The book is divided into three parts. The first is entitled the Discharge of Electricity through Gases; the second, Photo-electric Effects; and the third, Cathode Rays. The *raison d'être* of the whole book is found in the introduction to Part I.

"If we wish to study the relation between matter and electricity," the author says, "the most promising course is to begin with the relation between electricity and matter in the gaseous state; for the properties of a gas and the laws it obeys are simpler than for either a solid or a liquid—it is the state of matter which has been most studied, while the kinetic theory of gases supplies us with the means of forming a mental picture of the processes going on in a gas which is lacking for matter in its other states."

When the ether alone is considered, and when it is assumed to be at rest—a state in which both theory and experiment point to its being, "even when exposed to considerable mechanical forces, as it is when an electric wave is passing through it"—the electrical phenomena are fully "explained by laws which can be expressed mathematically by six very simple differential equations." It is not an easy matter to electrify a gas, and the first few pages are taken up with a discussion of the means employed by Mr. Townsend for securing this end, and the calculation of the charge carried by each particle of an electrified gas produced by the rapid electrolysis of sulphuric acid or caustic potash are worked out. This calculation depends upon the remarkable fact that when an electrified gas is admitted into aqueous vapour even far from the saturation point, a cloud is formed. The total charge in a vessel full of such cloud can be measured by an electrometer, and the radius, and therefore weight, of each drop can be calculated from the rate at which the cloud falls. The total weight of the cloud is, of course, found by direct weighing, and from these two factors the number of drops is obtained, and dividing the total charge in the cloud by the number of drops, the charge on each drop is found. The oxygen and hydrogen liberated by the electrolysis of an acid solution are

both electrified positively, but the former with only so small a charge that its presence is doubtful; whilst from caustic potash the oxygen bears a negative charge, but not so great as the hydrogen in the former case, whilst the hydrogen is scarcely, if at all, electrified. Some gases can also be electrified chemically, but one of the readiest ways is by the splashing of liquids. Thus the splashing of rain drops and the beating of the sea upon its beach both electrify the air around them; though, oddly enough, whilst the pure water from the clouds imparts a negative charge the salt-bearing water of the ocean gives a positive charge, to the air. Even when a light breeze causes ripples upon a pond a negative electric charge is imparted to the air, whilst the pond becomes positively electrified. These phenomena have led to the theory propounded by Lenard, that on the drops of water there are two superposed layers of electricity, one +, the other −; the rough treatment and the distortion of the drop when it strikes any resisting surface is enough to separate these electric layers, one adhering still to the drop, whilst the other goes into the surrounding gas or air. Thus diminishment of the area, as when the drop is flattened, liberates electricity; and, following Sir George Stokes, we may regard it as possible that when numbers of small drops come together to make one large thunder raindrop electricity is liberated, so that the large drops which fall in a thunder shower may be rather the cause than the consequence of the accompanying electrical phenomena.

The author then passes on to a consideration of the effects of electrification by Röntgen rays, and concludes the part with a few words about the marvellous results discovered by Becquerel, produced by radiation from the metal uranium and its salts, and these lead naturally to the second section on Photo-electric Effects. It is perhaps necessary to explain, as one may be easily led away by the memory of X-ray experiments, that these have nothing directly to do with photography, though the photographic plate may be used for their elucidation, but are the phenomena based on the discovery by Hertz in 1887, that ultra-violet light assisted a discharge if directed on the spark gap. With investigations of this nature the names of Elster and Geitel, of Righi and of Stoletow, are intimately connected. It is an interesting observation that "the sign of the electrification in the air produced by the action of light is the same as that produced in air by the splashing of drops of mercury or water," and it is thought that a disruption of one of two concentric layers may be caused by incident light in this case, just as it was by the concussion of the rain drops against the ground in that quoted above.

In this section some account of the experiments made on the electrification of gases by glowing metals and on the electrification in the neighbourhood of an arc discharge are given, and the conductivity of gases under different conditions is discussed. The section concludes with a very instructive record of the results and methods of electrolysis in gases. We quote the first paragraph because in it there appears to lie the key to the whole matter:—

> In the preceding account of the conductivity conferred on gases by light, Röntgen rays, and heat, we have seen that the phenomena can be explained on the supposition that the electricity gets through the gas by the movement of oppositely charged ions through the gas, the process being similar to that by which electricity is carried through an electrolyte. The passage of sparks through a gas furnishes us with additional evidence in favour of this view.

Dr. Thomson then goes on to describe Perrot's celebrated experiments made in 1860-61 on the passage of a discharge through water vapour, and passes on to an account of his own modification of Perrot's apparatus, and some of the results obtained with it. Again we quote:—

> The effect produced by electrification on the condensation of a jet of steam is shown in a very striking way by this apparatus. When the delivery tubes are open to the air, the steam after escaping from the nozzles goes some inches before it condenses sufficiently to form a cloud; as soon, however, as the coil is turned on and the sparks pass, brownish clouds reaching right down to the nozzles are at once formed. The cloud is denser in the steam which has gone past the negative electrode than in that which has gone past the positive.

The "brownish clouds" associated with the discharge, rightly or wrongly, call to one's mind the copper-coloured sky which forebodes thunder. There is another remarkable fact to which we cannot resist calling attention, and that is that, whereas in the electrolysis of water, hydrogen always comes off at the negative electrode and oxygen at the other, in the electrolysis of steam the gases come off sometimes at one and sometimes at the other terminal, according to the nature of the spark. We have so far overstepped our limits that we have no space left to devote to the last section of the volume. It deals with Cathode Rays, and fortunately the information about these is more widely distributed than that of which we have given some faint outline in this notice.

We put the book down with regret. Intentionally or unintentionally, Dr. Thomson has dealt with his subject in such a way as to keep, if we may be permitted so to express it, the *super*-natural side uppermost. It carries, therefore, with it a charm which too many scientific works lack. It is, moreover, a volume which affords no little food for conjecture and occasion for the exercise of the scientific imagination. Every page contains, briefly stated, the record of some fact, and many of these, we have little doubt, will be new to a large number of our readers. It is a book which we recommend to all the devotees of science, no matter into what particular branch their opportunities or tastes may lead them, for it is one from the perusal of which they cannot rise without feeling that their mental horizon has widened.

Railway Block Signalling. By JAS. PIGG, A.I.E.E. London: Biggs and Co., 139, Salisbury-court, E.C. 7s. 6d.

IN a short preface to this useful epitome of modern signalling, Mr. Pigg remarks that the tendency to employ automatic methods of train direction seems likely to increase, but he well observes that completely automatic systems do not admit of the selection and discrimination which are necessary where the traffic is not only very heavy but of extremely varied character. It does not appear to us that it will ever be possible in this country to dispense with the services of signalmen to any great degree, or that it would be very desirable even if practicable. The presence of skilled watchmen, as it were, looking after the general working of the whole railway machine from fixed and well-known points, able to summon assistance, and to adopt measures varying with each particular case, is an advantage not to be lightly thrown away in favour of cleverly-devised but unintelligent mechanical appliances.

Mr. Pigg's first chapter is mainly historical, and of much interest, tracing the development of block working from 1839 to the present time, with examples of the codes used on the Leicester and Swannington, and Birmingham and Gloucester Railways some fifty years ago. The extraordinary growth and complexity of modern traffic is well shown by comparing these with the elaborate signalling regulations of recent date, detailed on pages 34 to 70. A great variety of subjects unconnected directly with block signalling is discussed, such as signal whistles, head and tail lamps and discs as train describers, the reporting of trains in advance, the use of the telephone in railway working, and fog signalling, all find a place in Mr. Pigg's compendium. Block working itself begins to be treated of in Chapter IV., and is gone into very thoroughly and practically. The author is evidently quite at home in his subject, and gives cuts and full explanations of a great variety of modifications of the block system, such as the double-line block circuit instruments of Walker, Preece, Tyer, Winter, and other inventors. Elaborate diagrams illustrating the "lock-and-block" methods of Winter, Saxby and Farmer, and Sykes are given, enabling the differences between them to be easily comprehended. In all these the principal object aimed at is the same, viz., control of the starting signal at the entrance of a section by the man at the receiving end, and the rendering it impossible that a section should be entered till it is known to be clear throughout. There is an interesting description of the intricate signalling arrangements necessary at the swing bridge over the Ouse at Selby, on the North-Eastern Railway. The York and Hull lines diverging at the north end of the bridge, and the station yard commencing at the south end, whilst the traffic is very heavy, render it a most difficult place to work, but it has been successfully accomplished by the ordinary three-wire single-needle block instruments in conjunction with Sykes' lock-and-block applied to the indicators for the several lines. There are only two roads over the bridge which can be used at the same time, but the rails of two other roads are placed within these, so that the bridge is hardly any wider than usual. A cabin in the centre of the bridge is the point from which the hydraulic machinery for rotating it is worked, but it takes no part in the block working.

There is also a careful account of Sykes and O'Donnell's system of interlocking for single-needle instruments now being tried on the Great Northern at several places; and of Blakey and O'Donnell's method. Both of these are combinations of interlocking and automatic signalling, the train passing over treadles at each end of the section. In both cases there is very effective control of signals in advance by the box in the rear of them, as well as automatic intimation by the train itself of its entry into and exit from a section.

Some forty pages are devoted to various systems of single-line working, comprising especially the forms of electric staff now coming so generally into favour. In Chapter V. signal indicators are fully treated, with diagrams of the connections required to work them. This section includes indicators for signal arms, for points, as to whether lamps are alight or have gone out, and means for showing the state of the line near an out-of-sight advance signal, in order that a train waiting at it may not be forgotten. Several accidents of recent years seem to show an increasing need for ample security in the latter contingency. Mr. Pigg ably discusses methods of conveying audible signals to the drivers when fogs prevail; but the difficulty of hearing bells or gongs amid the noise of the engine, and the tremendous shock sustained by any external appliance when struck at high speed, seem to render this rather a hopeless field for improvement. We are inclined to agree with the author in his opinion that drivers should have more to do with calling out the fogmen than is now the case. The general state of the locality as regards fog must be better known to them than to the signalmen, who obviously can only judge of their own immediate surroundings. The book closes with a description of Timmin's automatic system of signalling on electric railways, and of the same inventor's ably-planned arrangements at the Earl's Court Station of the District Railway, where both signal arms, points, ground discs, and locking bars are worked by electricity, and the levers interlocked by the same agency. The book is carefully indexed, and has a table of the contents of the chapters. It will certainly be found of value to all students of practical railway business in the outdoor department.

Infinitesimal Analysis. By WILLIAM BENJAMIN SMITH Professor of Mathematics in Tulane University. Vol. i., "Real Variables." London: Macmillan and Co. 1898. New York.

THIS volume has been written on what appeared to the author, in the light of ten years' experience in teaching the Calculus, to be lines of least resistance. With this object the author has done well to restrict himself in this first volume to real variables, and to start at the outset with some familiar applications, to show the beginner the utility of the Calculus. The author has strewed some boulders in the road in the shape of definitions of infinitesimals, one-valued and many-valued functions, and of continuity, which raise difficulties, better kept out of sight of the beginner. But it is a difficult thing to settle the best order of presentation of the initial ideas; and if this order is made a strictly logical one, the effect is to make the book easier to read backwards than forwards. Integration is introduced at an early stage, and carried on simultaneously with differentiation. Here, again, the usual boulder is thrown down in the shape of Integration regarded as a summation; a method which soon gets into difficulties, and leads the author to point out the need of a better method—in short, the inverse method of differentiation, with which the student must be familiar to a certain extent before he can recognise the refinements of the arguments required in the method of direct summation. A useful table of reference is given of the principal differentiations, and the corresponding integrations; it would serve to explain a well-known difficulty if the integral 21—on page 79—was printed:—

$$\int \frac{d\,x}{x^2 - a^2} = \frac{1}{2a} \log \frac{x \sigma a}{x + a}$$

The manner in which the Elliptic Integral makes its appearance is dismissed in a useful note in § 125; the author might improve the occasion by showing the degenerance when the middle root e_2 of the cubic T approaches to coincidence with the upper root e_1 or the lower root e_3. The general treatment of Integration adopts the most recent procedure in utilising the hyperbolic functions, direct and inverse; these are denoted by *hc*, *hs*, instead of the vulgar-looking *cosh*, *sinh*. The author has done well in carrying Integration into the domain of mechanical preparation in determining centres of gravity and moment of inertia, thus clearing the ground for future applications. Numerous collections of well-chosen examples are interpolated, and the diagrams are carefully drawn; but we think the circle of curvature should be introduced into Figs. 29-32, with a view of showing its coincidence with the curve within the thickness of the line for an appreciable distance on each side of the point considered. We notice some novelties in terminology—*mediate derivative*, *prosthapheretic formula*, *absolute worth*, *anti-tangent*, *regressive differential quotient*, &c. The book is well printed on a large page, without crowding the type, and should prove useful in the country as a corrective to our arid and jejune academical treatises.

SHORT NOTICES.

Résistance des Bouches-à-Feu. Par P. Laurent. Paris: Gauthier-Villars, Quai des Grands-Augustins 55, and 20, Boulevard de Courcelles.—This work belongs to the "Scientific Encyclopædia of Aide-Mémoire," brought out under M. G. Isler. It deals with the strains falling on ordnance by mathematical investigation, beginning with the general question of gun tubes with jackets and hoops, and ending by a pretty full investigation of the conditions of wire ordnance. For a theoretical work, we think it unusually compact and business-like in each case, dealing first with the general conditions of the question, and then following it up with formula. Tables of factors of resistance are given at the end of the book.

Annuaire, 1899. Paris: Gauthier-Villars, Bureau des Longitudes, Quai des Grands-Augustins 55.—This year-book dates its origin from June 25th, 1795, when it was begun as one of many scientific efforts made by the savants of the French Republic. It has been kept up as an official work ever since that time. It contains astronomical and other scientific tables and data, and is well brought up to date, and without question is of high authority. The calculation of distances of the earth to the sun and moon are based on a value of the solar parallax adopted internationally in 1896, namely 8·8″. The tables of weights and measures, money, geographical measures, magnetic elements, and optical and electrical data, are brought up to date, and chiefly by M. Cornu. There are special chapters on balloon trials, by M. Bouquet de la Grye; geodesy, by M. Bassot; the observation and work of the Mont Blanc Observatory in 1898, by M. J. Janssen, and on the great equatorial telescope for 1900, of 60 metres focal length, and 1·25 metres aperture, now under construction by M. Gautier.

Small Accumulators: How Made and Used. An elementary handbook for the use of amateurs and students. Edited by Percival Marshall, A.I. Mech. E. Fully illustrated. The "Model Engineer" Series, No. 1. London: Dawbarn and Ward, Limited. Price 6d. net.—This forms the first of a series of popular scientific handbooks for amateurs and students, and it has been called into being, so the preface tells us, by the large number of requests for advice which have reached the author in his capacity as editor of the *Model Engineer and Amateur Electrician*. Although very little of the matter is new, yet it is all put forward in a new form, and in its sphere the book should be useful. It is practical and sound, and it contains that which is of great use to the non-technical worker, a glossary of the terms—electrical and otherwise—used throughout the book. In the beginning chapters the early history of accumulators is dealt with, and then the reader is taught how to make small batteries by constructing the cells and "pasting" and "forming" the plates. Modern commercial forms of battery are then discussed at some length, and the reader is told the firms which manufacture them. The charging of small accumulators is dealt with in an efficient and thorough manner, and useful hints given as to the arrangement of the cells with varying sources of electricity. Detailed instructions are also given as to the time taken to charge cells, and as to the way in which they should be worked. The book ends with a complete list of the uses of small accumulators, which include the lighting of domestic, factory, miners', and carriage lamps, decorations, medical uses, gas and oil engine ignition, fishing lamps, &c.

BOOKS RECEIVED.

The Behaviour of Railway Vehicles in Passing through Curves. From the German of Obermaschinenmeister. F. Hoffman, of Chemnitz. Madras: Printed at the Lawrence Asylum Press, Mount-road. 1898.

The Centrifugal Pump, Turbines, and Water Motors: Including the Theory and Practice of Hydraulics. (Specially adapted for engineers.) By Charles H. Innes, M.A. Second edition. Manchester: The Technical Publishing Company, Limited. London: John Heywood. 1898. Price 3s. 6d. net.

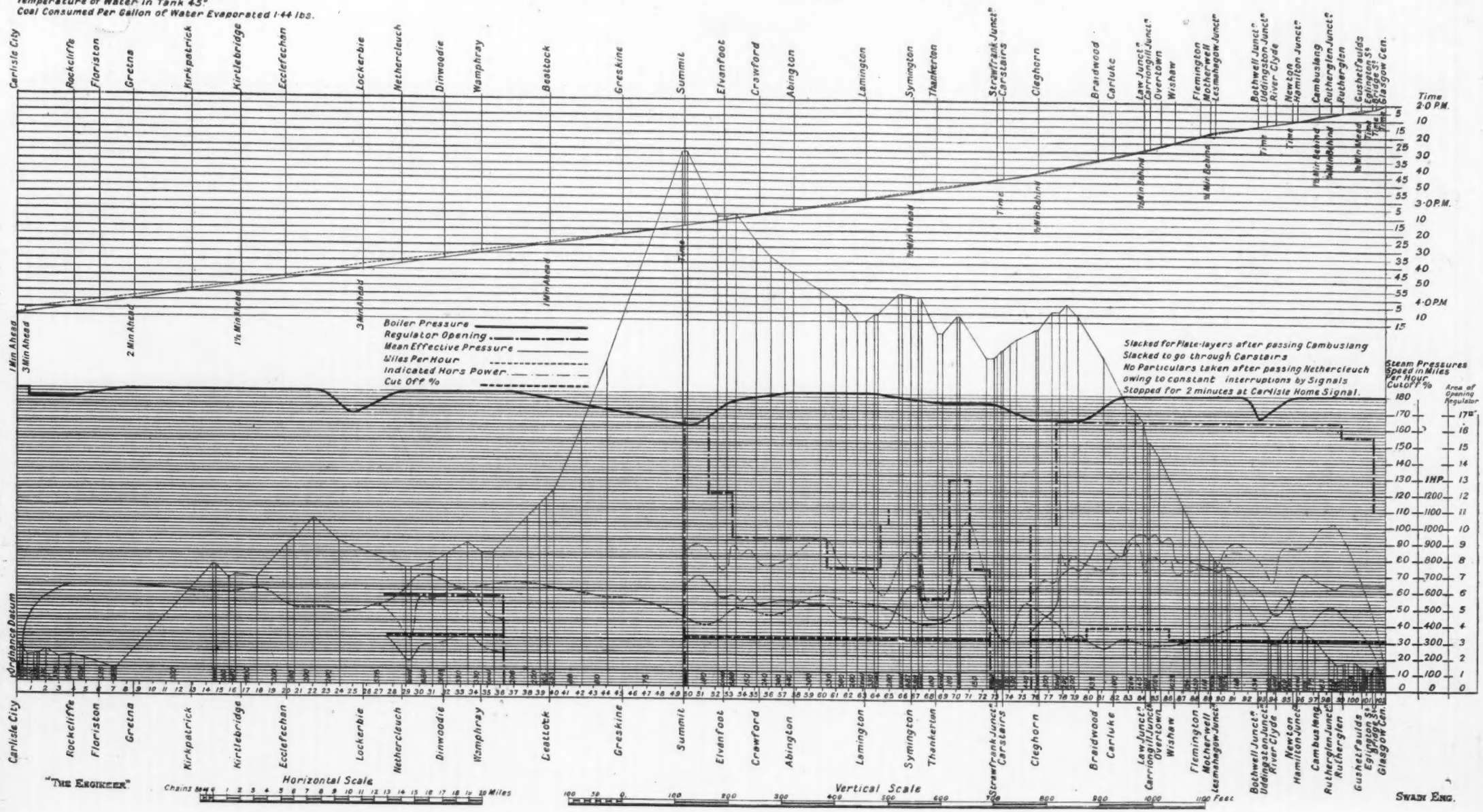
Excerpt Minutes of Proceedings of the Institution of Civil Engineers. Vol. CXXXIV. Session 1897-98. Edited by J. H. T. Tudsbury, D.Sc., Secretary. Chamier on "Culverts and Flood Openings," Chenhall on "Oxy-Chloride Copper Ores," Dalby on a "New Transmission Dynamometer," Dawkins on the "Relation of Geology to Engineering," Fowler on "Calcium Carbide and Acetylene," Garvie on "Latchford Lock Gates," Godfrey on the "Effects of Frost on Portland Cement," Preece on the "Electricity Supply of London," Jameson on "Testing the Strength of Materials," Stoney on "Extraordinary Floods in India," report of Committee on the "Thermal Efficiency of Steam Engines," and abstracts of papers on "Scientific Transactions and Periodicals." London: Published by the Institution, Great George-street, Westminster. 1898.

ENGINE TEST, CALEDONIAN RAILWAY

(For description see page 626)

Booked Time _____
Actual Time _____
Water Evaporated Per Mile 34·3 Gallons
" " Per lb. of Coal ·7 Gallons
Total Water Evaporated 3500 Gallons
Temperature of Water in Tank 45°
Coal Consumed Per Gallon of Water Evaporated 1·44 lbs.

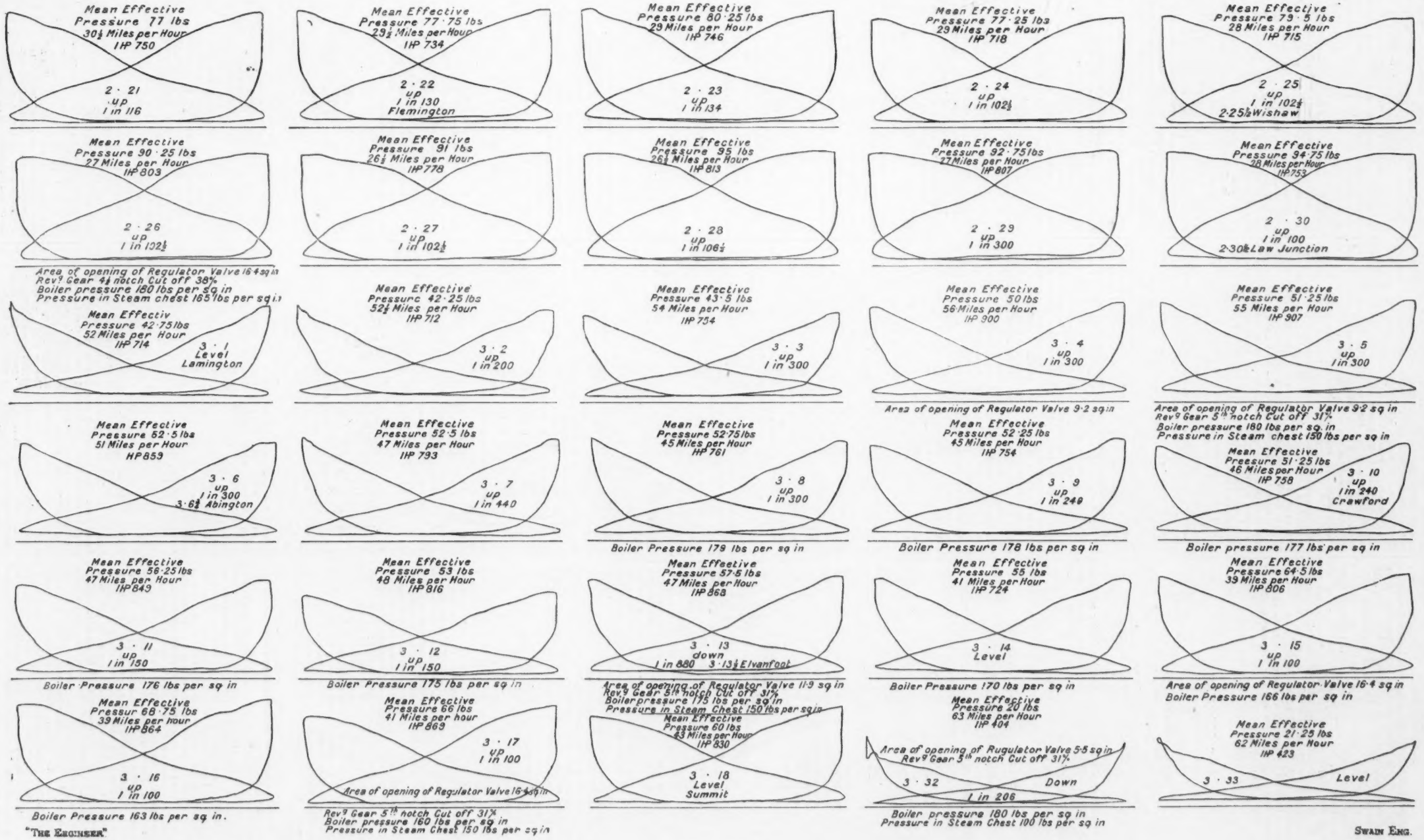
Table of Diagrams Shewing Results Obtained During Run on 2·0 P.M. Corridor Dining Train from Glasgow to Carlisle, 23rd February 1898 Engine No 772. Weight of Train Exclusive of Engine and Tender 305 Tons, 50 Pairs of Wheels. Total Length of Train 586 Feet



"THE ENGINEER" SWAN ENG.

ENGINE TEST, CALEDONIAN RAILWAY

(For description see page 626)

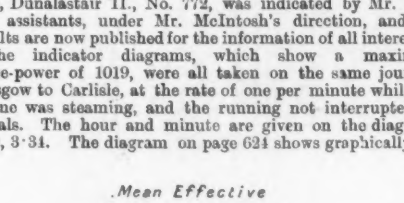

Mean Effective Pressure 77 lbs 30½ Miles per Hour IHP 750
2 · 21 up 1 in 116
Mean Effective Pressure 77·75 lbs 29½ Miles per Hour IHP 734
2 · 22 up 1 in 130 Flemington
Mean Effective Pressure 80·25 lbs 29 Miles per Hour IHP 746
2 · 23 up 1 in 134
Mean Effective Pressure 77·25 lbs 29 Miles per Hour IHP 718
2 · 24 up 1 in 102½
Mean Effective Pressure 79·5 lbs 28 Miles per Hour IHP 715
2 · 25 up 1 in 102½ 2·25½ Wishaw
Mean Effective Pressure 90·25 lbs 27 Miles per Hour IHP 803
2 · 26 up 1 in 102½
Mean Effective Pressure 91 lbs 26½ Miles per Hour IHP 778
2 · 27 up 1 in 102½
Mean Effective Pressure 95 lbs 26½ Miles per Hour IHP 813
2 · 28 up 1 in 106½
Mean Effective Pressure 92·75 lbs 27 Miles per Hour IHP 807
2 · 29 up 1 in 300
Mean Effective Pressure 94·75 lbs 28 Miles per Hour IHP 753
2 · 30 up 1 in 100 2·30½ Law Junction
Area of opening of Regulator Valve 16·4 sq in
Rev⁹ Gear 4½ notch Cut off 38%
Boiler pressure 180 lbs per sq in
Pressure in Steam chest 165 lbs per sq in
Mean Effectiv Pressure 42·75 lbs 52 Miles per Hour IHP 714
3 · 1 Level Lamington
Mean Effective Pressure 42·25 lbs 52½ Miles per Hour IHP 712
3 · 2 up 1 in 200
Mean Effective Pressure 43·5 lbs 54 Miles per Hour IHP 754
3 · 3 up 1 in 300
Mean Effective Pressure 50 lbs 56 Miles per Hour IHP 900
3 · 4 up 1 in 300
Area of opening of Regulator Valve 9·2 sq in
Mean Effective Pressure 51·25 lbs 55 Miles per Hour IHP 907
3 · 5 up 1 in 300
Area of opening of Regulator Valve 9·2 sq in
Rev⁹ Gear 5th notch Cut off 31%
Boiler pressure 180 lbs per sq in
Pressure in Steam chest 150 lbs per sq in
Mean Effective Pressure 52·5 lbs 51 Miles per Hour HP 859
3 · 6 up 1 in 300 3·6½ Abington
Mean Effective Pressure 52·5 lbs 47 Miles per Hour IHP 793
3 · 7 up 1 in 440
Mean Effective Pressure 52·75 lbs 45 Miles per Hour IHP 761
3 · 8 up 1 in 300
Mean Effective Pressure 52·25 lbs 45 Miles per Hour IHP 754
3 · 9 up 1 in 240
Mean Effective Pressure 51·25 lbs 46 Miles per Hour IHP 758
3 · 10 up 1 in 240 Crawford
Boiler pressure 177 lbs per sq in
Mean Effective Pressure 56·25 lbs 47 Miles per Hour IHP 849
3 · 11 up 1 in 150
Boiler Pressure 176 lbs per sq in
Mean Effective Pressure 53 lbs 48 Miles per Hour IHP 816
3 · 12 up 1 in 150
Boiler Pressure 175 lbs per sq in
Mean Effective Pressure 57·5 lbs 47 Miles per Hour IHP 868
3 · 13 down 1 in 880 3·13½ Elvanfoot
Area of opening of Regulator Valve 11·9 sq in
Rev⁹ Gear 5th notch Cut off 31%
Boiler pressure 175 lbs per sq in
Pressure in Steam Chest 150 lbs per sq in
Mean Effective Pressure 55 lbs 41 Miles per Hour IHP 724
3 · 14 Level
Boiler Pressure 170 lbs per sq in
Mean Effective Pressure 64·5 lbs 39 Miles per Hour IHP 806
3 · 15 up 1 in 100
Area of opening of Regulator Valve 16·4 sq in
Boiler Pressure 166 lbs per sq in
Mean Effective Pressur 68·75 lbs 39 Miles per hour IHP 864
3 · 16 up 1 in 100
Boiler Pressure 163 lbs per sq in.
Mean Effective Pressure 66 lbs 41 Miles per hour IHP 869
3 · 17 up 1 in 100
Area of opening of Regulator Valve 16·4 sq in
Rev⁹ Gear 5th notch Cut off 31%
Boiler pressure 160 lbs per sq in
Pressure in Steam Chest 150 lbs per sq in
Mean Effective Pressure 60 lbs 43 Miles per Hour IHP 830
3 · 18 Level Summit
Mean Effective Pressure 20 lbs 63 Miles per Hour IHP 404
Area of opening of Rugulator Valve 5·5 sq in
Rev⁹ Gear 5th notch Cut off 31%
3 · 32 Down 1 in 206
Boiler pressure 180 lbs per sq in
Pressure in Steam Chest 100 lbs per sq in
Mean Effective Pressure 21·25 lbs 62 Miles per Hour IHP 423
3 · 33 Level

"THE ENGINEER" SWAIN ENG.

THE INDICATED HORSE-POWER OF LOCOMOTIVES.

IN a recent article on express locomotives in THE ENGINEER, the author, Mr. W. M. Smith, alludes to an account by Mr. Rous-Marten which appeared in our issue of 25th February, 1898, of the performance of a Caledonian engine, and states that, unfortunately, no information has been given concerning the indicated horse-power. An engine of the class in question, Dunalastair II., No. 772, was indicated by Mr. Weir and assistants, under Mr. McIntosh's direction, and the results are now published for the information of all interested.

The indicator diagrams, which show a maximum horse-power of 1019, were all taken on the same journey, Glasgow to Carlisle, at the rate of one per minute while the engine was steaming, and the running not interrupted by signals. The hour and minute are given on the diagram; thus, 3·34. The diagram on page 624 shows graphically the



general results obtained as to time-keeping, boiler pressure, regulator opened, mean effective pressure, speed, horse-power, and cut-off, in relation to the contour of the line. The weight of the train hauled, exclusive of engine and tender, was 305 tons, and is a fair sample of the daily work done by this class of engine. We have commented on these diagrams on page 621.

LEGAL INTELLIGENCE.

SUPREME COURT OF JUDICATURE.—COURT OF APPEAL.

(*Before the* MASTER *of the* ROLLS *and* LORDS JUSTICES CHITTY *and* VAUGHAN WILLIAMS.)

J. LYONS AND SONS *v.* WILKINS.

THIS was an appeal by the defendants against the decision of Mr. Justice Byrne in a trade union case—reported in The *Times* of February 4th last and in the *Times* Law Reports, vol. 14, p. 208. The learned Judge granted a perpetual injunction restraining the defendants, Percy Cornwall Wilkins, Charles Clarke, Alexander Thompson, John Laverick, and Frederick Goodhall, from watching or besetting the plaintiffs' works or place of business and the approaches thereto for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, or for any purpose except merely to obtain or communicate information, and from watching or besetting the premises of Adolph Schönthal for the purpose of persuading or otherwise preventing him from working for the plaintiffs, or for any purpose except merely to obtain or communicate information. The learned Judge also gave £5 damages in respect of a libel, but there was no appeal from that part of the judgment. The action arose out of a strike of the plaintiffs' workpeople, which took place in January, 1893. The plaintiffs were leather bag and portmanteau manufacturers in Redcross-street. Adolph Schönthal did work for them at his own premises, employing his own workmen. The defendant Wilkins was the secretary of the Amalgamated Trade Society of Fancy Leather Workers, which was registered under the Trade Union Act, 1871; the defendant Clarke was the chairman of the society, and the other three defendants were the trustees of the society. The strike arose out of a dispute about wages and the dismissal of the defendant Thompson by the plaintiffs pending the settlement of that dispute. An interlocutory injunction was granted by Mr. Justice North in 1896, and his order was afterwards affirmed, with some modification in the terms of the injunction, by the Court of Appeal—*cide* the *Times* Law Reports, vol. 12, pp. 222, 278. Before Mr. Justice Byrne gave his decision the case of "Allen *v.* Flood" had been decided by the House of Lords—the *Times* Law Reports, vol. 14, page 125, 1898, A.C., page 1—and by reason of that decision Mr. Justice Byrne refused to restrain the defendants from maliciously inducing or conspiring to induce persons not to enter into contracts with the plaintiffs. The plaintiffs did not appeal from that part of the decision. It was admitted that there had been no physical violence or obstruction by the defendants. There had been only "picketing" and peaceful persuasion by the defendants of workpeople not to work for the plaintiffs, though very strong language had been used to women in particular. By the Conspiracy and Protection of Property Act, 1875 (38 and 39 Vict., c. 86) section 7, "Every person who, with a view to compel any other person to abstain from doing or to do any act which such other person has a legal right to do or abstain from doing, wrongfully and without legal authority" (*inter alia*) "(4) watches or besets the house or other place where such other person resides, or works, or carries on business, or happens to be, or the approach to such house or place, shall, on conviction thereof by a Court of summary jurisdiction, or on indictment as hereinafter mentioned, be liable either to pay a penalty not exceeding twenty pounds or to be imprisoned for a term not exceeding three months, with or without hard labour. Attending at or near the house or place where a person resides or works, or carries on business, or happens to be, or the approach to such house or place, in order merely to obtain or communicate information, shall not be deemed a watching or besetting within the meaning of this section.' The appeal was argued on November 30th and December 1st, when judgment was reserved. The arguments on the appeal will be found reported in the *Times* of December 1st.

Mr. W. H. Cozens Hardy was for the appellants; Mr. Eve, Q.C., and Mr. Ward Coldridge were for the respondents.

The Court dismissed the appeal.

The MASTER of the ROLLS said:—The construction put by this Court on 38 and 39 Vict., c. 86, sub-sections 3 and 7, when this case was heard in March, 1896—see 1896, 1 Ch., 811—is adverse to the appellants, and was, in my judgment, correct. Having reconsidered my own judgment, I see nothing to recall or qualify. Upon the present appeal, however, one or two important questions were raised which do not appear to have been considered on the former occasion, and to them I will confine myself. The great point made by the appellants' counsel turned on the word "wrongfully" in section 7 and on the effect of "Allen *v.* Flood" (1898, A.C., 1) on the meaning of that word. He contended that to "watch and beset" another person's house was only illegal if done—(1) with a view to compel him to abstain from doing, or to do some act, which he has a right to do or not to do; (2) wrongfully and without legal authority. He further contended that nothing could be said to be wrongful which did not violate some right of the complainant; and that there was nothing wrongful in watching or besetting a house simply in order peacefully to persuade others to conduct themselves in some particular way which was not unlawful for them to follow. This argument is, in my opinion, based on a misconstruction of Section 7. This section is a penal section, and the words "wrongfully and without legal authority" must be inserted in an indictment or information framed on the enactment, and the specific acts which the complainant was to be compelled to do or not to do ought also to be specified in a conviction by a magistrate—see "The Queen *v.* McKenzie," 1892, 2 Q.B., 519. Moreover, if on the trial the evidence before the Court is consistent with the legality of the acts complained of, this reasonably possible legality must be excluded by evidence before the accused can be properly convicted. But it is not necessary to show by other evidence than that which proves the overt acts complained of the legality of them if no justification or excuse for them is reasonably consistent with the facts proved. This is the principle always applied in criminal prosecutions in which the words "feloniously," "wrongfully," or "maliciously" are introduced into the charge and have to be proved before the person accused can be properly convicted. That this is the correct method of construing and dealing with the words "wrongfully and without lawful authority" in Section 7 is, in my opinion, perfectly plain if attention is paid to sub-heads 1, 2, 3, and 5, to which those words are as applicable as they are to sub-head 4. If the overt acts mentioned in sub-head 1, for example, in using violence or intimidation are proved, and it is proved that they were done with a view to compel, &c., and there is no reasonable ground for justifying them, it is unnecessary to give further evidence to prove that they were committed "wrongfully and without legal authority" — see "The Queen *v.* McKenzie," at pages 521-3. If this be true of all the sub-heads except 4—watching and besetting—I can discover no justification for giving the words "wrongfully and without lawful authority" any different meaning or effect when applied to 4—viz., "watching or besetting." The truth is that to watch or beset a man's house with a view to compel him to do or not to do what it is lawful for him not to do or to do is wrongful and without lawful authority unless some reasonable justification for it is consistent with the evidence. Such conduct seriously interferes with the ordinary comfort of human existence and ordinary enjoyment of the house beset, and such conduct would support an action on the case for a nuisance at common law—see "Bamford *v.* Turnley" (3 Bd. Sm., 62), "Brooke *v.* Saillard" (2 Ch. D., at page 701, per Jessel, M.R.), "Walter *v.* Selfe" (4 De G. and Sm., 315), and "Crump *v.* Lambert" (L. R., 3 Eq., 409). Proof that the nuisance was "peaceably to persuade other people" would afford no defence to such an action. Persons may be peaceably persuaded provided the method employed to persuade is not a nuisance to other people. Another point made by the appellants' counsel was that what was done to Schönthal gave the plaintiffs no cause of action. This point was raised and considered and decided by the Court on the former appeal, and I might say no more. But as I do not remember whether the particular argument urged by Mr. Hardy was used on that occasion, I will add that, in my opinion, his contention cannot be supported. It is based on the expression "such other person." It is said that to beset one person's house with a view to compel some one else is not within the section. Such a construction would render the Act nugatory in a great number of cases clearly within the mischief intended to be remedied. But a more direct answer to the argument is that "such other" means "any other." This seems plain if attention is paid to the language of the first part of the section where these words first occur. Moreover, the word "person" in the singular must be read so as to include "persons" in the plural—see 52 and 53 Vict., c. 63, s. 1—and if this is borne in mind, the argument is seen at once to be untenable. His Lordship then referred to "Allen *v.* Flood," which, he said, was of no real use in construing the Act now in question, and he continued as follows:—As regards the facts the evidence was amply sufficient to prove the plaintiffs' case. The whole object of what was done was to compel the plaintiff to comply with Mr. Wilkins' terms, and although there was no violence or overt threat of violence, it is quite plain that the relays of men set to watch and beset the plaintiff's house—and the house of Schönthal, who worked for him—were sent to do, and that they did, a great deal more than "attend" where they were "in order merely to obtain or communicate information." It is all very well to talk about peaceful persuasion and to draw fine lines between persuading and giving information. In this case there is no difficulty whatever in coming to the conclusion that what was done was watching and besetting as distinguished from attending "in order merely to obtain or communicate information." That the provisions of the Act were infringed appears to me to be plain and beyond all reasonable doubt. The appeal must be dismissed with costs.

LORD JUSTICE CHITTY said:—This appeal by the defendants is limited to the injunction granted by Mr. Justice Byrne against watching and besetting. The injunction is, in the terms of the order, pronounced by the Court of Appeal on the motion. He postponed giving judgment until after the decision of the House of Lords in "Allen *v.* Flood," and after consideration he held that "Allen *v.* Flood" did not affect the decision of the Court of Appeal on the motion, but that it did preclude him from granting a further injunction which the plaintiffs asked for. There is no appeal by the plaintiffs. The facts proved at the trial were to the same effect as those given in evidence on the motion, except that in two instances Mr. Justice Byrne held that the evidence of actual interference was not so strong. He found that it was clearly proved that the appellants watched and beset the plaintiffs' works or place of business and the approaches thereto for the purpose of persuading or otherwise preventing persons from working for the plaintiffs, and for purposes other than that of merely obtaining or communicating information. This finding of facts is accepted by counsel on both sides. It was admitted by the plaintiffs' counsel that the pickets, as they are called, used no violence or intimidation or threats. The picketing extended over some months, covered all the working hours of the day, and was conducted by relays of men in succession. The object in view was clearly shown by the white cards distributed by the pickets, and the other documents referred to. The picketing and the acts done by the pickets were done with a view to compel the plaintiffs to abstain from doing or to do acts which the plaintiffs had a legal right to do or abstain from doing, viz., to compel them to change the mode of conducting their own business. To avoid any possible misapprehension, I state that the strike itself was lawful. The question on the appeal, in my opinion, turns on the 7th section of the Conspiracy and Protection of Property Act, 1875. The construction and effect of that section were dealt with by this Court on the motion, and the decision then arrived at is binding on us, subject only to the point whether it can be shown to be erroneous, as being in conflict with "Allen *v.* Flood." I am unable to see that it is. The point decided in "Allen *v.* Flood" is that an act lawful in itself is not converted by a malicious or bad motive into an unlawful act, so as to make the doer of the act liable to a civil action. No such general question of motive arises in the present case. The sole question is whether upon the facts the case is brought within the 7th section. To bring a case of watching or besetting within the section it must be shown that the watching or besetting was done with a view to compel a person to abstain from doing or to do any act which such person has a legal right to do or abstain from doing. That the watching and besetting were done with that view is found by the Judge and not disputed. "View" does not import motive. It imports purpose. Speaking for myself, I prefer standing by the words which the Legislature has thought fit to employ. The acts complained of were done with the view stated in the section. Then it was urged that the watching and besetting mentioned in the fourth sub-section was not rendered unlawful by the section where it was done for the purpose of persuading workmen to abstain from taking work from the person sought to be compelled. I cannot accept that proposition. I think that where the view is established the only case in which watching or besetting is allowed, or, in other words, is not unlawful, is that mentioned in the proviso at the end of the section, viz., where the attending at or near the house or place where a person resides or works, or carries on business, or happens to be, or the approach to such house or place is "in order merely to obtain or communicate information." attending in order to persuade is not within the proviso. It is noticeable that the first section of the Act of 1871, which Act is repealed by the Act of 1875, contained no such proviso, and that the seventh section is more favourable to those who watched or beset. Mr. Cozens-Hardy, jun., in his argument for the appellants, fastened on the words "wrongfully and without legal authority," and contended that they showed that the watching or besetting mentioned in the fourth sub-section were acts lawful in themselves unless it were shown in some way other than by proof of the facts of watching or besetting with the view mentioned at the beginning of the section that the acts done were done wrongfully or without legal authority. But this argument cannot be sustained. "Wrongfully and without legal authority" applies equally to all the five sub-sections; and to take—by way of illustration—the first sub-section, the using of violence or intimidation, or injury to property there specified are all of them unlawful acts in themselves. No just or sound construction of the section would permit words which in terms apply to all the sub-sections being confined to one sub-section only. But further, the acts of watching and besetting here proved in reference to the fourth sub-section and done with the view mentioned were acts in themselves unlawful at common law, and are not made lawful by the Legislature. In my opinion they constitute a nuisance at common law. True it is that every annoyance is not a nuisance; the annoyance must be of a serious character and of such a degree as to interfere with the ordinary comforts of life. To watch or beset a man's house for a length of time and in the manner and with the view proved would undoubtedly constitute a nuisance of an aggravated character. It must be borne in mind that the 7th section, although it probably arose out of trade disputes, is not confined to trade disputes or to disputes between masters and men. It applies equally to all her Majesty's subjects of every class. It would embrace the case of besetting a man's house with a view to compel him not to receive guests or visitors. Further, I think that the whole argument on the words "wrongfully and without legal authority" is founded upon a misapprehension. The acts mentioned in the 4th sub-section being in themselves unlawful, the words "wrongfully and without legal authority" are inserted to provide for any unforeseen case in which the evidence of the overt acts may possibly show some lawful excuse or justification, or, to speak perhaps more correctly—as "authority" is said to cover "excuse," see "The Queen *v.* Harvey," L.R., 1 C.C.R., 284—lawful authority or justification. The term "wrongfully" and its meaning in law were dealt with incidentally by many of the Lords who advised the House in "Allen *v.* Flood." It will suffice to quote one passage to be found in Lord Herschell's speech, where he cites with approval the statement by Mr. Justice Crompton in his judgment in "Lumley *v.* Gye" (2 Ell. and Bl., 216) that it must now be considered clear law that a person who "wrongfully and maliciously or, which is the same thing with notice interrupts the relation subsisting between master and servant, commits a wrongful act." With regard to Schönthal, it was decided on the motion that the watching and besetting of his house or shop with a view to compel the plaintiffs were illegal acts on the part of the defendants for which the plaintiffs could sustain an action against them. On this appeal Mr. Cozens-Hardy raised what may have been a new point founded on the words "such other person" which run throughout the 7th section. It was urged that besetting the house of one person with a view to compel another is not within the section. I think it is. Grammatically, "such other" refers to "any other person," the immediate antecedent. Besetting a workman to compel a master and besetting a master to compel a workman are both plaints within the mischief aimed at. Schönthal was an outworker for the plaintiff. The result is that the appellants have failed to show that the decision of the Court on the motion is in any way overruled by "Allen *v.* Flood," or by any principle laid down in that case.

LORD JUSTICE VAUGHAN WILLIAMS, in concurring, thought that the case was concluded by the judgment of the Court of Appeal on the interlocutory application, and that it was not affected by the decision of the House of Lords in "Allen *v.* Flood."—*Times.*

TUNNEL VENTILATION.—In order to prevent dampness and too low a temperature in the Boston subway, four ventilating fans have been put in, and periodical observations of temperature and humidity are being taken in order to show the results. The subway is partly tunnel and partly cut-and-cover work of steel and concrete, built to carry the electric tramways under a congested section of the city where the narrow streets have a heavy traffic. It is partly two-track and partly four-track. The fans are placed in chambers, with trumpet-mouth openings into the side of the tunnel, and the air exhausted is discharged through chimneys, those for the double-fan installations being 11½ft. diameter. The fans are of the Sturtevant cone type, each consisting of a cast iron concidal centre, with steel annular back plate, and a series of reverse curve blades of steel plate, by which the direction of the air current is changed from axial to radial. They are placed vertically, close against the opening into the tunnel, and are all designed to have a capacity equivalent to a complete change of air every fifteen minutes in the section ventilated. Two of the fans are 7ft. in diameter, delivering 30,000 cubic feet of air per minute when running at 175 revolutions per minute. These require about 7-horse power each under ordinary atmospheric conditions, or 1-horse power at half speed under the same conditions. Two other fans are 8ft. diameter, with capacities of 37,000 cubic feet of air at 170 revolutions, requiring 10-horse power at full speed and 1¼-horse power at half speed. Each fan is driven by a Sturtevant electric motor, direct connected to the fan shaft by an insulated coupling. They are shunt-wound for maximum speed at 550 volts, and arranged for series or parallel operation. The maximum rise of temperature for ten hours' continuous operation is 45 deg. for the armature and 50 deg. for the commutator or fields.

FIREPROOF WOOD FOR WARSHIPS.—The lessons of the battle of the Yalco in regard to the danger from fire on warships in action, and the similar lessons of the recent battle of Santiago, have influenced the Navy Department in deciding upon the use of fireproof wood for the three new battleships. This wood has been in use on a monitor and nine gunboats since 1895, but in 1897 a board of naval officers advised its abandonment as being heavier, harder, and weaker than untreated wood, while the chemicals contained corroded metals in contact, injured wearing apparel in drawers made of the treated wood, and prevented the adhesion of paint. Mr. Hichborn, the Chief Naval Constructor, however, claimed that these objections were largely imaginary, and of far less importance than the fireproof properties. This latter view has been sustained, and it is recognised that all woodwork in the superstructure should be made non-inflammable. The process employed in treating the timber for the new battleships somewhat resembles that of creosoting. The timber is placed in a cylinder 7ft. diameter, and 105ft. long, built of ⅜in. steel plate, and holding 15,000ft. board-measure of timber. When the ends have been closed and hermetically sealed, low-pressure steam or aqueous vapour at a temperature of 110 deg. to 200 deg. is admitted, and continued for from one to eight hours, or until the cells of the wood are well opened. The moisture is then drawn from the wood by creating a vacuum in the cylinder. When all the moisture has been extracted and drained off, the cylinder is filled with the fire-proofing solution, which consists essentially of phosphate of ammonia and sulphate of ammonia, and this solution is forced into the cells of the wood under pressure. When the gauge shows that the absorption is complete, the solution is drawn off, the cylinder is opened, and the wood taken out. It is then kiln dried at a temperature not exceeding 125 deg. The Navy Department requires that the dry timber, when subjected to a heat of 600 deg., will remain uninflammable and safe against the spread of fire from the point of contact.

A NOTEWORTHY BOILER EXPLOSION.

IN THE ENGINEER for September 9th, 1898, we published a short article under the heading above, dealing with an explosion of a vertical boiler which took place at Norwich a few days before. According to the reports which reached us and were current in Norwich, the boiler in question was being tested at the time by Messrs. Tidman and Sons, and we wrote, "We are somewhat at a loss, in the first place, to understand what Messrs. Tidman endeavoured to find out, and, in the second, to know how the Board of Trade will deal with them." The report of the Board of Trade has just been issued, and we reproduce it in full. It will be seen that Messrs. Tidman have been entirely exonerated. We have only to add that we did not intend to cast any imputation of any kind on Messrs. Tidman. The case appeared to us to be one in which a boiler exploded while it was being tested—a novel event, and one well worth recording. It appears, however, that no test was being carried out, that Messrs. Tidman and Sons were in no way concerned in the getting up of steam by the owner of the boiler, and their very small share in the matter will be gathered from the evidence, and the decision of the Board of Trade inquiry.

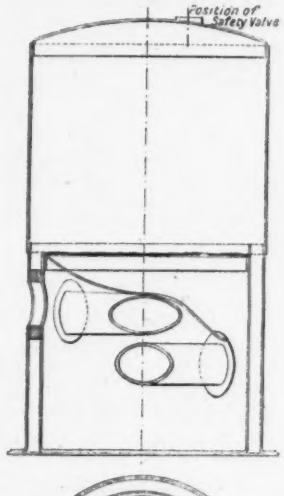
EXPLOSION OF A BOILER AT ST. GEORGE'S, BRIDGE-STREET, NORWICH.

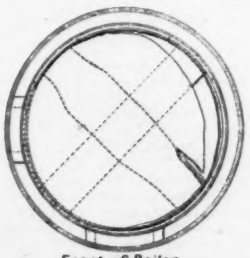
IN pursuance of our appointments, dated September 10th, 1898, we held a formal investigation in the above matter, at the Council Chamber in the Guildhall, Norwich, on October 13th, 14th, and 15th, 1898. Mr. Gough appeared for the Board of Trade, Mr. E. C. Wild was counsel for Mr. Samuel Warburton, and Mr. Bousfield, and Mr. Jones represented Messrs. Tidman and Sons, and Mr. John C. Archer, a fitter in their employ. Having heard and carefully considered the evidence, we beg to report as follows:—

Date and place of explosion.—The explosion occurred on September 5th, 1898, on the site of the new Technical school, Norwich.

Name and address of owner.—Mr. Samuel Warburton, Lord-street, and Clifton-street, Miles Platting, Manchester.

Persons killed and injured.—Robert Watts died on September 9th from injuries received. John Crickmore Archer, William Proudfoot, and Edward Rivett were all more or less seriously scalded.





Front of Boiler
Horizontal Section Thro Steam Space
Heavy Full Lines Show Complete Fracture Thro Plate
Heavy Dotted Line Indicates Position of Cracks on Top Side of Plate

Description and principal dimensions of the boiler.—The boiler was of the vertical cylindrical type, and was made throughout of iron. It was 7ft. 1in. high, and 4ft. in mean diameter, and was fitted with two cross tubes in the fire-box, and a side flue leading to an external uptake. The cylindrical portion of the shell was made up of two belts of plates, with two plates ⅞in. thick in each belt. The bottom edge of the lower belt was flanged outwards for attachment to a foundation plate ½in. thick. The shell crown was formed into the segment of a sphere; it was ⅞in. thick, and it was dished upwards about 5in. and flanged downwards at its outer edge for attachment to the shell. The fire-box was 3ft. 2in. high and 3ft. 6½in. in external diameter, and was composed of two plates originally ⅞in. thick, flanged inwards at the bottom for attachment to the foundation plate. Its crown plate, also ⅞in. thick, was flanged similarly to the plate which formed the shell crown. The cross tubes were each 8in. in external diameter, welded longitudinally, and flanged at their ends for attachment to the fire-box. The flue was at the side and near the top of the fire-box; it was 9in. in diameter, formed with a solid ring 2½in. thick, fitted between the shell plate and the fire-box. The boiler was lap-jointed and single riveted throughout with rivets ⅞in. in diameter, spaced 2½in. apart. A manhole 9½in. by 14in. was cut through the front portion of the crown plate of the boiler, and a mud-hole 4½in. by 3in. was cut through the lower part of the shell—Fig. 1. The mountings consisted of one safety valve 1¾in. diameter, loaded by lever and movable weight; one glass water gauge, one steam pressure gauge, one cock between the boiler and the feed check valve, one blow-off cock.

Name of maker and age of boiler.—The boiler was made by Mr. A. Hollins, of Farsley, near Leeds; we were unable to ascertain its age.

Particulars and dates of repairs.—A patch was put on the mud-hole in 1894 by Mr. Tom Naylor Brown, a dealer in contractors' machinery, of Leeds, but we heard of no substantial repairs.

Persons or societies who have inspected the boiler.—The boiler was regularly inspected by inspectors in the employ of the Boiler Insurance and Steam Power Company, now the Vulcan Insurance Company, from 1890 to 1893, the last examination made by them being on the 23rd February, 1893.

Nature of the explosion.—The crown plate of the fire-box ruptured round its circumference at the knuckle of the flange, and was torn away for a distance of about 7½ft., forming a large aperture, through which the contents of the boiler escaped into the fire-box, and from thence out of the fire hole—Fig. 1.

Cause of the explosion.—The explosion was caused by the crown of the fire-box having been forced down by excessive pressure, whereby it was fractured nearly through at its outer edge, and in consequence it was unable to withstand the pressure to which it was subjected.

Remarks.—At the conclusion of the evidence we were asked by Mr. Gough to state whether the explosion was caused by the neglect of Mr. Thomas Curtis, and, if so, whether Mr. Tom Naylor Brown was responsible for such neglect? Whether the explosion was caused by the neglect of Mr. Tom Naylor Brown? Whether the explosion was caused by the neglect of Mr. Arthur Roberts? Whether the explosion was caused by the neglect of Mr. William H. Bousfield, and, if so, whether Mr. Samuel Warburton was responsible for such neglect? Whether the explosion was caused by the neglect of Mr. Samuel Warburton? Whether the explosion was caused by the neglect of Mr. Robert Tidman, or by the neglect of Mr. John C. Archer, and, if so, whether Mr. Robert Tidman, senior, Mr. Frederick Tidman, and Mr. Robert Tidman, junior, trading as Messrs. Robert Tidman and Sons, are responsible for such neglect?

Having heard the respective parties, and Mr. Gough in reply, we stated as follows:—"In or about the year 1890, Mr. George Lax, a builder, of Leeds, was the owner of a boiler made by Mr. A. Hollings, of Farsley, near Leeds, at a date which we have been unable to ascertain."

Having described the construction of the boiler, as appears on page 1, we further stated as follows:—"From 1890 to 1893 the boiler was insured by Mr. Lax with the Boiler Insurance and Steam Power Company, now the Vulcan Insurance Company, by whose inspectors it was regularly examined from time to time. The maximum working pressure, as stipulated in the policy, was that of 60 lb. per square inch; but Mr. Lax worked the boiler at a pressure of 45 lb. or 50 lb. per square inch. Mr. Lax, having no more use for the boiler, instructed Messrs. Oliver and Appleton, auctioneers, of Leeds, to sell it, and in 1894 it was bought by Mr. Curtis, on behalf of Mr. Tom Naylor Brown, a dealer in contractors' plant, at Leeds, for the sum of £50. Mr. Brown only once subjected it to steam pressure, and that not exceeding 40 lb. per square inch, for the purpose of ascertaining whether the connection to one of the cylinders which had been made on his premises was tight. Having put a patch on the mud-hole, where it appeared to have been leaking, and having supplied a new false bottom to the mortar mill, he caused it to be advertised in the *Machinery Register*, published by Messrs. A. Roberts and Co., of King-street Chambers, Leeds. This advertisement, which appeared in the May issue of the *Register*, was seen by Mr. Samuel Warburton, a builder and contractor, of Manchester, who was then under contract with the Corporation of Norwich to erect some new technical schools in that city. It was as follows:—

"8011.—One 6ft. 6in. pan, with double cylinder, vertical engine and boiler combined, under-driven on strong wrought iron girder carriage, 20ft. long, on road wheels, new false bottom, &c.; strong."

Having read this advertisement, Mr. Warburton communicated with Mr. Arthur Roberts, the sole member of the firm of Messrs.

A. Roberts and Co., and a great deal of correspondence passed between the parties, to some of which we must refer. Mr. Roberts having quoted several mortar mills for sale, and having alluded to this one as No. 8011, as appears in the advertisement, wrote to Mr. Warburton under date, May 17th, 1898, as follows:—

We duly received your telegram this morning, asking if you can inspect all three mills in one hour to-morrow morning, to which we replied, by wire, saying that Nos. 13,522 and 16,586 were sold, but that No. 8011 was still for sale here at Leeds, and that we have not heard from the owner of No. 13,782 saying whether still for sale. We expect to have a letter from the owner of No. 13,782 in the morning saying whether still for sale. If it is still for sale, it is to be seen at Dewsbury, and you could inspect No. 8011, and then go on and inspect the one at Dewsbury say in two hours. The one here in Leeds is a very powerful mill, and if you saw same, we think you would purchase it. It is only a short distance from our office.

On the following day Mr. Warburton met Mr. Roberts by appointment, and accompanied him to a yard, where he saw the mortar mill, Mr. Curtis, Mr. Brown's clerk, being present. Mr. Warburton, having looked at the mill, said, according to his account, "It looks all right," and, addressing Mr. Curtis, "I take it from you that it is all right—you mean that it has been thoroughly overhauled," to which Mr. Curtis replied, "Yes, it has." Mr. Warburton informed us that he was then referring to the whole machine, and not solely to the mortar mill. Mr. Curtis, owing to ill-health, has not been examined as a witness, but Mr. Roberts has denied that Mr. Curtis ever in his hearing asserted, directly or indirectly, that the machine had been overhauled. We have come to the conclusion that Mr. Warburton's recollection cannot be at fault, and, as we attach credence to his evidence, we find that Mr. Curtis did return an affirmative answer to the interrogation, "you mean that it has been thoroughly overhauled." What was in fact said or assented to is, to our minds, not very material, for here commenced a series of mistakes and misunderstandings which, but for the fact that they may have in some measure conduced to the explosion and lamentable loss of life and injury to person, might be described as ludicrous. As the mortar mill had been overhauled, and the sum of £32 expended on repairs to it, Mr. Brown has explained and contended that it was the mill only to which Mr. Curtis was alluding when he assented to Mr. Warburton's question, and with this contention we agree, and find that Mr. Warburton's question referred to the whole machine, mortar mill, engine, and boiler, but that the answer of Mr. Curtis referred only to the mortar mill.

On 21st May Mr. Roberts wrote to Mr. Warburton as follows:—

We have also carefully estimated the weight of the above—referring to the mortar mill—and calculate it to weigh about 10 tons, as near as possible. It is a very good mill, the one we could recommend you to go in for.

In a letter written by Mr. Roberts on the 26th May the following is contained:—

We shall be very pleased to have your order for this—the mortar mill—as it seems the one best adapted for your purpose, but, privately, we should advise you to settle about it quickly, as we have it on offer elsewhere.

On June 2nd Mr. Roberts wrote thus:—

Re the mortar mill with engine and boiler, which you inspected here in Leeds. We have seen the owner *re* this, and he informs us that he cannot reduce the price at all. P.S.—This is a very strong mill, and we think it is very cheap. We may say that if you don't take it, the price will be advanced to £120.

On the 30th June Mr. Roberts wrote another letter, to which the parties to this investigation attach great importance. It reads as follows:—

We thank you for your letter of yesterday *re* No. 8011. One 6ft. 6in. mortar mill with vertical engine and boiler combined, as inspected by you here in Leeds. We accept the offer you make of £115, and have accordingly purchased the mortar mill from the present owner. We will load it up at Leeds Station for £105, thus allowing you £10, which amount the carriage will about come to, as we never pay carriage on second-hand goods, and we cannot afford to risk anything in carriage, as we have not much more than 2½ per cent. on it. We presume this will be satisfactory to you, and shall be pleased to have your further confirmation. We may say that you are getting a bargain, as we have again inspected the mill to-day, and everything seems in very good condition, some of the parts being new, as you would no doubt notice when you were over. You will also remember that we said there was no chimney with it, but we have since found a chimney which belongs to it, and we will send same along with the mill. It is as strong a mill as we have ever seen

We have to consider the proper meaning to be put on the words "we have again inspected the mill to-day." To any ordinary person we think this language would imply that Mr. Roberts had inspected the mill, which word he has admitted must include the whole machine, having done so on some previous occasion, in the sense that he had thoroughly examined it. Mr. Roberts, however, has told us that he never meant to convey such an impression, and, while admitting the word "inspected" was infelicitous, has stated that what he meant to convey to Mr. Warburton was that he had seen the machine, and, considering it a heavy and powerful one, would, if sound, suit Mr. Warburton, and that, in fact, the word "inspected" should have been written "seen." In furtherance of this contention he has stated that it is not the custom of dealers in second-hand machinery to inspect what they are trying to sell to intending purchasers, but the latter buy at their own risk, and in this contention with regard to the usage of the trade he has been confirmed by Mr. Brown, and he has also prayed in aid of it the footnote which appears at the end of all his letters:—

Second-hand goods.—An inspection is often advisable, as after goods have left senders no liability can be acknowledged.

We give as much credence to the evidence of Mr. Roberts as we do to that of Mr. Warburton, for we believe that they are both reliable and truthful witnesses. We accept Mr. Roberts' explanation of the meaning of that letter; but at the same time we must accept what Mr. Warburton told us—that he was led to believe from a perusal of this and the other letters that the machine as a whole had been inspected by Mr. Roberts, and by him found to be in very good condition. Hence there was another misunderstanding between the parties.

On July 2nd, 1898, Mr. Warburton again went to see the mortar mill, principally for the purpose of measuring its height so as to ascertain whether he could get it into the place where he desired to work it. Mr. Roberts saw him at that time and said to him:—"I hope you will take it because I have bought it from the owner."

The mortar mill was definitely bought by Mr. Warburton in August, 1898, for the sum of £105, it having been previously purchased by Mr. Roberts from Mr. Brown for the sum of £95.

It was then delivered by railway at Norwich, and taken to the site of the new technical schools, where it was received by Mr. William Harker Bousfield, the foreman at Mr. Warburton's works, who erected it on the iron frame. Finding the rods and scrapers of the mill to be bent, Mr. Bousfield summoned Mr. Robert Tidman, a member of the firm of Messrs. Robert Tidman and Sons, engineers, of this city, who in consequence, on Monday, 29th August, sent Robert Green, a blacksmith in his employment, to do the necessary repairing work. About the same time Mr. Tidman was asked by Mr. Bousfield whether he could couple the engine with the boiler, which Mr. Tidman undertook to do, but advised that, as the engine appeared to be very rusty, it should be first taken to pieces, and its rusty portions cleaned. Mr. Tidman also engaged to fit the boiler with a new glass water gauge, the old one having been broken in transit. To do this work Mr. Tidman sent Mr. Archer, a fitter in his employ. No instructions were ever given as to an examination of the boiler, as has been admitted by all the parties.

While receiving the above-mentioned order, Mr. Tidman saw the lever of the safety valve of the boiler lying on the ground, and as it was both bent and rusted, he suggested to Mr. Bousfield that he should make a new one, and on the latter assenting, he did so. The new one was of the same length, but a little heavier. It was afterwards fitted in place, but by whom we have not been able to ascertain.

Mr. Archer proceeded with his work, and on the afternoon of Wednesday, August 31st, was engaged with William Downes, an engine-fitter's assistant, in fitting the new water gauge. The manhole lid had been removed from the boiler, and Downes went inside to fix the nuts to secure the gauge. During this operation he observed that the crown of the fire-box was down about 4in. or 5in. He put his head through the manhole and acquainted both Mr. Archer and Green with this fact; and he also told Mr. Bousfield, when he shortly afterwards appeared. Mr. Archer then looked through the hole in the boiler intended to receive the bottom gauge pipe, and having satisfied himself that the furnace crown was down, he reported the fact to Mr. Tidman, his employer, shortly afterwards.

Subsequently, Mr. Bousfield determined to subject the boiler to hydraulic pressure, to ascertain whether it was tight. Accordingly, on September 1st, a pump having been lent by Mr. Tidman, Mr. Bousfield instructed Green, the blacksmith, to connect the pump with the boiler, and having filled the boiler, to work the pump. This Green did until Mr. Bousfield called out 80; meaning that the steam pressure gauge registered 80 lb., there being no gauge on the pump; the water then leaked though the safety valve, which was subsequently held down, and a little more pressure was applied.

Slight leakage was then discovered from the flange of the crown of the fire-box below the rivets. Green caulked the flange, and having put the pump on again, ascertained that the job was tight.

On Saturday, September 3rd, it was determined to get up steam for the purpose of running the engine, to ascertain if it was in working order. Reuben Chance, an engine driver in the employ of the Corporation of Norwich, who was in charge of a Pulsometer close at hand, was asked to light the fire, and did so. Steam was got up to 50 lb. or 60 lb., the glass of the water gauge being three quarters full, and the engine having been run for about half an hour, the fire was drawn.

On Monday, September 5th, Reuben Chance again lit the fire; steam showed at 9 a.m., and subsequently the engine was started, the glass of the water gauge showing three quarters full. After running for a short time, the engine was stopped on account of some of the caps of the bearings being loose, when Mr. Archer heard the safety valve blow off. He did not, however, look at the pressure gauge, but put on the feed pump to reduce the pressure, and kept it on for twenty minutes. The engine having been again started, Mr. Archer found that the scrapers were loose; he therefore stopped the engine and fastened them up. Having again started the engine, he ascertained that the bolts of the frame of the mortar mill were loose. He stopped the engine again, and was proceeding to fasten the bolts when the boiler exploded.

The crown plate of the fire-box was ruptured round its circumference at the knuckle of the flange, and was torn away for a dis-

tance of about 7½ft. A large aperture was thus formed, through which the contents of the boiler escaped into the fire-box, and from thence out from the fire-hole.

Unfortunately, Mr. Archer, William Proudfoot, Edward Rivett, James Riches, and a boy named Robert Watts were all more or less seriously scalded. They were removed to the hospital, where Watts succumbed to his injuries on the 9th September. On his body an inquest was held, and the jury found that "he died from the accidental explosion of a defective boiler."

After the explosion, the boiler was examined by Mr. Joseph Williams, engineer surveyor to the Board of Trade, who found that the crown of the fire-box was fractured nearly through the plate, there being evidence of other and old fractures. Mr. Williams was of opinion that the crown had come down from over pressure, as he discovered no signs of overheating to account for its collapse, and that in its condition at the time of the explosion it was not fit for any steam pressure at all. Assuming the crown to be in its original form, and the plates ⅞in. thick, allowing something for deterioration from their original thickness, Mr. Williams calculated the collapsing pressure to be that of 130 lb. per square inch, and thought that the boiler might have been worked with a factor of safety of 4, or at about 33 lb. per square inch. Mr. Williams found that the safety valve was loaded to 100·47 lb. per square inch, and that it was in an indifferent condition, for its top was not level, and the centre of rotation of the fulcrum was considerably lower than the top of the valve, so that when the valve attempted to lift, friction was produced. The centre of gravity of the weight, too, was not in line with the centre of gravity of the lever. On testing the steam pressure gauge, Mr. Williams found it to be about 5 lb. light.

Having examined the boiler, we have come to the conclusion that the explosion was caused by the crown of the fire-box having been forced downwards by excessive pressure, whereby it was fractured nearly through at its outer edge, and was in consequence unable to withstand the pressure to which it was subjected.

We have been unable to ascertain the age of the boiler, but although, as far as we saw, the shell plates were in good condition, we have no doubt but that it was of very considerable age, which is shown by its design, the crown of the fire-box having no support at all, and the uptake passing through its side.

In answer to the questions which have been asked us by the Board of Trade, we have to state that the boiler was not in good condition when it was sold by Mr. Tom Naylor Brown in or about the end of June last.

Mr. Tom Naylor Brown did not represent to Mr. Samuel Warburton that the boiler was in good condition and fit for the purpose of supplying steam to the engine to work the mortar mill, but we think that Mr. Warburton was justified in thinking that such representations were made by Mr. Curtis, Mr. Brown's clerk, although the latter did not intend to make them.

Mr. Arthur Roberts did not verbally represent to Mr. Warburton that the boiler was in good condition and fit for the purpose of supplying steam to the engine to work the mortar mill. But Mr. Warburton thought that such representations were made in the letters from Mr. Roberts; and we are of opinion that he was in some measure put off his guard by the expressions contained in those letters, and thought that the whole machine was represented as being fit to work; but we must observe that Mr. Roberts never stated at what pressure it could be safely worked.

Before purchasing the mortar mill Mr. Warburton did not cause it to be examined by any competent person, and, notwithstanding the representations which he thought had been made to him by Mr. Curtis and by Mr. Arthur Roberts, he was not justified in neglecting to have the boiler so examined. He should have employed some independent person to have examined it.

Mr. Warburton did not ascertain the pressure at which the boiler could be safely worked.

Mr. William Harker Bousfield did not ascertain the pressure at which the boiler could safely be worked.

Mr. Bousfield was informed that the crown of the fire-box was bulged downwards, but he then took no measures, proper or otherwise, to ascertain the condition of the boiler, and the pressure at which it could safely be worked.

The boiler was tested by hydraulic pressure to ascertain whether it was tight, and for no other purpose; the test was neither judiciously nor properly applied, and the boiler was not examined before, during, or after the test, as it should have been.

Mr. Robert Tidman was aware that the crown of the fire-box was bulged downwards, but he was not informed how much it was down, and did not apprehend danger from this fact. Being aware that Mr. Bousfield's attention had been called to it, he did not think that it was his duty, not having been consulted as to its condition, nor even asked to look at it, or to interfere in the matter. He assumed, and, in our judgment, was justified in assuming, that the foreman to a contractor like Mr. Warburton would take the necessary steps to keep his plant in safety. We are of opinion that under the circumstances it was no part of his duty to have given any warning to Mr. Bousfield.

Mr. Archer was aware that the crown of the fire-box was bulged downwards. He appeared to have at first apprehended danger from this fact, although his fears were afterwards, so he told us, lulled by the application of the water test. Having reported the fact to his employer, his duty, we find, was then performed.

We cannot find that any person was in charge of the boiler during repairs. But we are of opinion that some person should have been appointed to have charge. We find that Mr. Archer was not in charge, and there was no duty cast on him to ascertain the pressure at which the boiler could safely be worked.

No measures were taken either by Mr. Warburton or by Mr. Bousfield to ensure that the boiler was being worked under safe conditions.

The explosion was not caused by the neglect of Mr. Curtis.

The explosion was not caused by the neglect of Mr. Tom Naylor Brown.

The explosion was not caused by the neglect of Mr. Arthur Roberts.

Mr. Wild, the learned counsel for Mr. Warburton, has stated that that gentleman desires to take all the blame, if any, that may attach to Mr. Bousfield or any other of his employés. We are, however, prepared to say that no blame attaches to Mr. Bousfield, for he did not know, nor did he at any time pretend to know, anything about the management of this or any other boiler.

The position of Mr. Samuel Warburton is very different. He has told us that he has bought numerous other boilers second-hand, and has mentioned the names of two eminent firms from whom he has so purchased, and by whom he has been informed that the boilers they sold had been overhauled. We think, therefore, that he was justified in assuming that those particular boilers were fit for some pressure; but he never ascertained by inquiry or otherwise for what pressure they were fit.

In this case he thought, and, as we have already stated, had some reason for thinking, that the boiler had been overhauled, but he never inquired even from the vendor, at what pressure it could be worked, much less did he appoint some competent person to ascertain this pressure for him. With his other boilers he has been singularly fortunate, for he has met with no mishap with them. His good fortune has now deserted him, not without cause. He had obtained from the Corporation of Norwich an important contract, and that Corporation would expect that the plant he used in the performance of it would be kept in a reasonably safe condition, so as not to be dangerous to their own workmen—and there was one employed close to the boiler at the time of the explosion—to his workmen, and to the inhabitants of this city. To ensure this what should Mr. Warburton have done? Before purchasing the boiler he should have satisfied himself, beyond all doubt, by independent advice, that the boiler was fit for steam pressure, and should not have relied on supposed representations made to him by a vendor, of whom he knew nothing, but to whom he was merely introduced by means of an advertisement. Having bought the boiler, he should then have definitely determined at what pressure it could safely be worked with a reasonable margin of safety, and this it is not disputed that he did not do. If he had employed some competent person to examine the boiler before it was bought, or afterwards, before it was used, he would have most certainly been advised that it was not fit for any steam pressure at all in the condition in which it was. His neglect to adopt these precautions has caused the explosion, and for this neglect we must hold him to blame.

There is another point which, we regret to say, we must make against Mr. Warburton, and that is that there was no competent person in charge of the boiler, for he does not pretend that Mr. Bousfield was competent. If there had been, the explosion would have been prevented, for when the crown of the fire-box was reported to be down, such competent person must have examined it, and he would forthwith have ascertained that there was a crack through it.

We very much regret having to make these remarks, because we are of opinion that Mr. Warburton did not neglect this boiler from any unworthy motive, such as parsimony; but this neglect arose from immunity from danger with regard to his other boilers, which, from what he has told us, have probably often been worked under circumstances of grave danger, and beyond doubt without reasonable precautions to ensure their safety.

Mr. Warburton has frankly stated the course he has adopted with this and his other boilers, and has not attempted to conceal anything from us, but has throughout the matter behaved like an honourable gentleman. It would be impossible, however, for any reasonable person to maintain that he has not been guilty of negligence. In our judgment he has been guilty of very serious negligence, for which we have to pronounce him to blame.

For the reasons which we have already stated, the explosion was not caused by any neglect on the part of Mr. Archer or of Mr. Tidman.

We directed that Mr. Samuel Warburton should pay to the solicitor to the Board of Trade the sum of £100 towards the costs and expenses of this investigation.

Dated the 25th day of October, 1898.

HOWARD SMITH, J. H. HALLETT, } Commissioners.

The Assistant-Secretary, Board of Trade.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

A new crusher and pulveriser.—The Williams hinged-hammer mill is a new form of crushing mill which is being used for grinding, crushing, and pulverising stone, cement, coal for foundry facings, brick, bones, ore, oil cake, &c., and also for shredding bark for tannery use. On a 4in. horizontal shaft are keyed a series of discs, on the faces of which are projecting bolts. On each bolt is loosely hung a hammer bar, which is a rectangular bar, rectangular in section, 4in. by 1½in., and fitting loosely on the bolts, so that it has an arc of movement of about a third of a circle. Each disc carries thirteen hammer bars, and there are six discs in the machine, making seventy-eight hammers. The machine runs at about 1000 to 1500 revolutions per minute, and the hammers grind the material fed to it by a combination of abrasive and percussive action. As each hammer strikes the material it recoils, passing such of the material as is not shattered by the blow. A movable breaker plate forms the lining, and the material is crushed between this and the hammers, passing out through a cage screen at the back of the machine. The plate and cage bars can readily be renewed, and the bars can be set out as they wear, or replaced by new bars made at blacksmiths' shop. In case of foreign matter—such as railway spikes, or horseshoes—getting into the machine, the hammers will give enough to let it pass. Special advantages are claimed for the direct blows as compared with a mere dead grinding pressure; it can be used for wet as well as dry material, and is employed in brick yards for working clay. For such material a steam jacket is used to prevent clogging. The cage or screen can be set for any desired size or degree of fineness of output, according to whether the material is to be granulated or pulverised to an impalpable powder.

The Lowell Textile School.—This school was opened in January, 1897, to give the practical instruction necessary in the cotton, woollen, worsted, and other textile industries, and instruction in the sciences and arts as applied to these industries. The equipment consists of high-grade machinery, specially built to afford facilities for experimental work, and of much greater variety than is to be found in any one mill. The plant represents a cost of £15,000. In the day classes there are four separate courses, each of which requires three years for its completion—(1) the cotton manufacturing course, (2) the woollen manufacturing course, (3) the designing course, (4) the chemistry and dyeing course. One term of preliminary instruction is given in the first year, consisting of principles of mechanism, machine drawing, textile calculations, elementary designing, and elementary chemistry. Towards the end of this term, each student decides which course he will follow. The evening classes are intended for those who are at work in the mill during the day. They include the manufacture of cotton and woollen yarns, weaving on all kinds of looms, designing, cloth construction, analysis and reproduction, colour, textile calculations, chemistry and dyeing. There are day classes for women in art subjects, especially in textile designing. Popular illustrated lectures on subjects connected with the textile industries are also given. The fees for the evening classes vary with the courses. For the day classes the fee is £20 per year, with a cost of about £3 for text-books, tools, instruments, &c. Of the 257 students, seventy-two are day students. The school is incorporated under the Massachusetts State laws, by officers and directors of several of the great textile corporations of the State. The professorships include those of mechanics, decorative art, weaving, cotton spinning, woollen and worsted spinning, chemistry and dyeing, and textile design and fabric structure.

Marine notes.—A shipbuilding company at Chicago has received orders for two of the largest vessels on the Great Lakes, and these will be used mainly in the ore, coal, and grain-carrying business. One will be a steamer, and the other a barge, or consort to be towed by the steamer, each vessel being 433ft. long on the keel and 500ft. long over all. The cost will be about £80,000. The same company is also building a large and fast steamer to make the run between Chicago and Mackinac, on Lake Michigan, in less than twenty-four hours, the guaranteed speed being 17 miles per hour. The vessel will be 240ft. long and 40ft. beam, with a draught of 12½ft., and will cost 50,000 dols. The Bessemer Steamship Company, which owns a fleet of the newest and largest freight boats on the Great Lakes, has placed an order for a steamer 475ft. long and 50ft. beam, to carry 8000 tons of ore, and a barge 460ft. long, 50ft. beam, and 30ft. deep, to carry 7500 tons of ore on a draught of 17½ft. The barge will be a consort of the steamer, which will have quadruple-expansion engines. The new fireboat for the Chicago fire department, which has recently been launched, has a steel hull 118ft. long, 24ft. beam, and 12½ft. deep, with a draught of 10ft. It will be equipped with three sets of vertical double-acting steam pumps and two boilers, and will be propelled by a single screw and triple-expansion engine. It will throw 24 streams of water, the largest stream being from a 5in. nozzle, and the streams can be thrown to a height of 200ft. The new double-deck double-screw ferry boat put on by the Southern Pacific Railway to run between San Francisco and the railway terminal at Oakland, across the bay, has seats for 1000 passengers in the cabin and for 735 more passengers at the open ends of the boat. The vessel is a double-ender, with a screw at each end, and does not have to turn round.

Portable pneumatic riveters.—The various forms of portable pneumatic riveting devices which are now in use—and some of which have been illustrated in THE ENGINEER—are effecting a considerable improvement in the time and cost of riveting on structural and other work, and especially in shipbuilding, where there are numerous corners and cramped spaces in which it would be difficult and tedious to do hand riveting. For deck plating, &c., a little riveter mounted on an iron frame on wheels is used in conjunction with a pneumatic "hold-on" or "dolly" underneath. The machine leaves a slight burr and cap over the countersink, which is chipped off with a chisel, and a few blows from the machine smooths off the surface. The work is remarkably rapid, and is excellent in quality, the fierce shower of sharp blows heading up and compressing the metal before it has time to cool as much as in hand riveting. The machines are so small that they can be used in any confined space. With a pneumatic riveter and pneumatic hold-on, three men and a heater boy can drive 800 to 1000 rivets per day. The wide introduction of these machines has been influenced largely by the strikes among the ship riveters, which have caused delay and annoyance at most inconvenient times. The saving over piecework prices for hand riveting in the shipbuilding yards on the Lakes is from a halfpenny to a penny per rivet, with an aggregate saving of £800 to £1000 over hand work for an ordinary Lake steamer of 4000 tons. Owing to the rapidity of the work, and the heat at which it is finished, the joints are better and tighter than those made with hand riveting and require less caulking. On one of the steel skeleton frame buildings in Chicago the field riveting was done with portable pneumatic riveters.

AUSTRALIAN NOTES.

(From our own Correspondent.)

AFTER a considerable amount of controversy between the Newcastle colliery proprietors and men, over the "weighing" question, it has been agreed among the proprietors to advance the price of coal from 6s. 9d. to 8s. per ton, which is to take place from January 1st next; at the same time the hewing rate is to be advanced from 2s. 9d. to 3s. 2d. per ton. The question of weighing the skips was not discussed, and it is expected that this matter will now be dropped by the men.

Negotiations have been pending for some time past for treating the New Caledonian copper and nickel ores by the Smelting Company of Australia, Lake Illawarra, N.S.W. The manager of the company, Mr. Weinberg, has gone to New Caledonia to arrange for the smelting to be done at these works instead of shipping the ore to Europe. It is stated that upwards of 100,000 tons of nickel ore will be shipped during the current year, and the output of copper ore will be from 6000 to 7000 tons per month.

The total gold exports of Australasia last year were £13,476,347, made up by the various Colonies, as follows:—

New South Wales	1,563,920
Victoria	4,379,264
Queensland	2,598,723
South Australia	361,301
West Australia	3,143,857
Tasmania	176,288
New Zealand	1,252,994
	£13,476,347

One of the greatest law cases on record in New South Wales has just been brought to a conclusion. The case arose over extras claimed by Mr. M'Sharry, the contractor, over the building of the Cootamundra to Gundagai Railway. The amount claimed was £115,000, to which was afterwards added another £35,000 for delays in connection with the waterways.

The writ was issued by Mr. M'Sharry against the Government in February, 1894, at which time Mr. C. G. Heydon, Q.C., was appointed arbitrator, who, after disposing of some preliminary matters, resigned his position.

In June, 1896, Mr. T. Barton, Q.C., was appointed arbitrator, under a compulsory order of reference.

The case for Mr. M'Sharry closed on February 11th, having lasted 113 days, the evidence of Mr. M'Sharry alone covering 2439 pages of type-written foolscap. The Crown entered upon its defence on February 17th, and continued for ninety-two days: the evidence in reply tendered by Mr. M'Sharry occupied thirty days.

The outcome of the case is that the arbitrator has allowed £13,408, out of the £150,000 claimed.

ALMANACS, DIARIES, &c.

WE have received some very tastefully produced calendars and blotters, which serve pleasingly and usefully to remind us of that old-established and well-managed institution—the Sun Fire Office, from which they emanate. We find that the Sun Fire Office was established as far back as the year 1710. The premium income in 1897 exceeded £1,000,000, insuring a sum of over £425,000,000.

Amongst the issues for next year coming under the category of the above, we have received this week a neat wall calendar from the Hunslet Engine Company, Leeds; from the works of Messrs. E. R. and F. Turner, Limited, Ipswich, there is a calendar of the "tear-off" pattern, and on the back of the card is given, in legible type, a quantity of useful postal and other information. Some firms appear to us to make a mistake in sending out wall calendars of unwieldy size, very effective no doubt as posters, but too big for valuable office space. Such a calendar has been sent us by the Rugby Portland Cement Company. It is extremely well done, but we feel sure that it would be found more universally acceptable if only about half the present size.

THE INSTITUTION OF JUNIOR ENGINEERS.—A meeting of this Institution was held at the Westminster Palace Hotel on December 9th. Mr. Kenneth Gray, vice-chairman, presiding, in the absence of the chairman, Mr. Basil H. Joy, who had not returned from the United States. The paper read was on "British Cable Tramways and their Construction," by Mr. E. A. Heath. For towns in hilly districts requiring tramway communication, the author claimed that cable haulage had no rival. Being independent of rail adhesion the steepest gradient could be ascended or descended with absolute safety, provided that, for descending an emergency brake were employed which would grip the slot rails. A brake of this description was fitted to the cars on the Douglas tramway—gradient 1 in 10—and on those of the Matlock line with a gradient of 1 in 4½. The system of constructing the track and cable tube were described in detail. A very good fish joint for track rails was shown which formed practically a continuous running surface for the car wheels. The rail head was planed off half its width, and the outside fish-plates rolled to fill the recess. Main and terminal pits were dealt with; also machinery for hauling the cable, and method of threading it. Approximate figures were given for calculating the horse-power required to haul the cable; to arrive at anything approaching the actual figure, mature experience of the various conditions under which the tramway was to be operated, had to be applied. The special features in the construction of Highgate cable tramway, Streatham, Douglas, Matlock, and others, were reviewed, particulars being furnished. In the discussion which ensued, Messrs. Julian, E. Marshall, T. Meacock, Gentry, C. Lean, W. J. Hunter, H. B. Vorley, H. Durtnall, R. Krall, A. P. Macalister, E. A. Berry, J. Pearson, L. H. Rugg, and W. J. Tennant took part. The proceedings concluded with the announcement of the ensuing visit to Messrs. Yarrow's works, Poplar, on the 17th December, and of the meeting on January 27th, when Professor J. A. Ewing, Hon. M. Inst. J.E., would deliver a lecture on "Measurements of Elasticity."

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE activity reported last week in the manufactured iron branches in preparation for the holidays has continued throughout this week, but the new orders given out have been necessarily limited. Prices, however, are thoroughly well preserved, and there is no expectation of consumers being able to secure easier terms next year. There is no shaking the marked bar makers in their demands for the full price of £8 per ton, and considering the way in which pigs and fuel are keeping up, the chances are that a further advance of 10s. per ton in this class of finished iron may be recorded in 1899. Customers, therefore, having orders to place cannot do wrong in giving them out. There is an improved demand for best iron from abroad, more particularly from Australia and other British Colonies, and this is always regarded by the marked bar houses as a very healthy sign. The common bar makers remain very busy, and the manner in which this department of the market keeps up is one of the most favourable features of the whole trade. Makers hold firmly to £6 10s., and are declining deliveries for next year at less than £6 12s. 6d. to £6 15s. per ton. An official advance to the latter figure is regarded as likely early next month. Hoops are moving off freely at £6 15s. to £7, and best ditto, £8; rivet iron, £8 10s.; tube strip stands at £6 to £6 2s. 6d. per ton.

The sheet iron makers are sharing more than previously in the revival, though the aggregate output in this district is still far below that of recent years. This circumstance is, of course, to be accounted for by the entry into the trade as producers of the Principality and other new districts. Sheets of 20 w.g. are quoted £6 17s. 6d. to £7 2s. 6d.; 24 w.g., £7 2s. 6d. to £7 5s.; and 27 w.g., £7 15s. to £8 per ton. Large orders were reported as having come to hand for galvanised corrugated sheets from the Antipodean and South African markets. The association price continues at £11 to £11 10s. at outports, and it is by no means improbable that at the January quarterly meeting, owing to the continued advance in spelter and black sheets, a further advance may be declared. In the best-informed quarters of the market a distinct feeling is becoming manifestly opposed to the too rapid forcing up of prices for any class of manufactured iron and steel, as certain only to give an additional handle to the already troublesome American and Belgian and German competition. And this caution is entirely wise. What course the finished iron makers are, however, to pursue in self-defence, if the pig iron makers and the coalmasters continue to demand higher rates, it is difficult to see.

Pig iron values are firm, with a strong tendency to a higher level, although rates are now nearly 3s. per ton more for Staffordshire sorts, and about 6s. more per ton for Midland brands than before the present revival. Stocks of pig iron are smaller than they have been for a long time, but although the pig iron business must be remunerative, smelters show no disposition at present to blow in more furnaces. While, however, manufactured iron masters complain of the high prices of pig iron, smelters in their turn bewail the dearness of ironstone and cokes. Ironstone for Staffordshire has now to be procured from distant parts instead of being mined close to the furnaces. Oxfordshire ironstone raised in the Banbury district is now being used at Bilston, at which latter place there is plenty of ironstone in the earth, but at too great a depth for its mining to be undertaken as a commercial speculation.

Staffordshire forge iron is, at date, 92s. for cold blast; 66s. 6d. to 69s. 6d. for hot-air all-mine; 56s. to 57s. 6d. for ordinary ditto; 48s. to 50s. for part-mine; and 45s. to 46s. for cinder. Both forge and foundry are scarce and dear, and prices now rule at the best level of the year. Northamptonshire forge is 49s. to 50s., and North Staffordshire, Derbyshire, Nottinghamshire, and Leicestershire are quoted 50s. to 52s. Staffordshire part-mine foundry is offered at 55s., common foundry at 47s. 6d., and all-mine foundry at 72s. and upwards.

Local engineering houses note with satisfaction that some large engineering contracts are under execution in New Zealand and West Australia, and that although the contracts are placed with colonial houses a considerable share of the work appears to be finding its way into English hands. The West Australian Government is spending money very freely, both for minting machinery and waterworks. The low freights charged from the United States to Australia are, however, evidently contributing very much to the development of American competition in the colonial markets.

Copper values have on the week increased by about 6s. 3d. per ton. Quotations are about as follows:—G.M.B. cash, £55 16s. 3d. to £56 1s. 3d.; three months, £56 1s. 3d. to £56 6s. 3d.; tough, £58 15s. to £59 5s.; best selected, £59 10s. to £60, strong sheets, £66.

The district steel works are very busy, and arrangements are being made to curtail the holidays as much as possible. The prospects for next year are extremely promising, and a good weight of this year's orders will have to be carried over in spite of great efforts to work off as many contracts as possible before the year's end. Heavy sections are in great demand, and a large tonnage of steel boiler plates are under order. The great demand for steel in the shipbuilding industry, &c., in the North is restricting the importation of Scotch and North of England steel into this district. Local steel makers, consequently, get more orders and are able to ask better prices. Boiler plates have been advanced to £8 per ton; superior qualities, £9; rivet steel bars, £7; and manufactured rivets, £8. On rivet steel the advance is £1 per ton from the bottom, and on boiler plates 30s. Steel sheets for working up have been advanced to £7 15s. for 24 gauge, and £8 7s. 6d. for 27 gauge. Best deep stamping sheets are £10 to £12, according to gauge. Basic steel bars are £7 to £7 2s. 6d., and girders £6 5s. to £6 10s. Agents for imported steel quote £5 to £5 5s. for Bessemer blooms and billets, and £5 5s. to £5 10s. for best Siemens.

Work is still abundant in the engineering and machinery branches, and most of the heavy ironfounders are busy, more particularly on gas and water mains and structural work. There is not quite so much doing in machine tools as lately reported, and the cycle and cycle-fitting branches continue remarkably dull for the time of year. The cycle tube branch continues in an unremunerative state, but for steel boiler tubes a very fair demand is experienced, more particularly from the national dockyards and arsenals, and in this branch some revival of earning power ought to be shortly apparent. Makers of brass and copper tubes are doing fairly well, but their harvest is still to come, when the numerous vessels now under construction on the Clyde and elsewhere are approaching completion. The various Birmingham and district industries connected with railway enterprise continue to exhibit a good deal of vitality. Orders are still pouring in for railway rolling stock, underframes of iron and steel, axles, springs, nuts, bolts, rivets, &c.

It is alleged this week that a "ring" exists in North Staffordshire among the producers of puddling mine for ironworks fettling purposes, with a view to keep up prices, and that producers are very conservative as to whom they supply. Even regular consumers are at the mercy of the "ring," and as regards outsiders it is practically impossible for these people to buy at all. Prices which twelve or eighteen months ago were about 13s. per ton have now advanced to 19s., or something like that. Purple ore, also used for fettling the furnaces in the forges, has advanced still more. Prices of this material have advanced some 100 per cent., the old quotation of 10s. 6d. per ton having now advanced to 20s. 6d. One occasion for this is that a stock of some 25,000, formerly held by one producer in South Staffordshire, has now entirely disappeared, and current supplies have therefore run short. Tap cinder from the forges, and which is now a valuable aid to the steel smelters, has also doubled its price.

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Throughout the iron and steel trades of this district the business of the year is closing very satisfactorily, with a strong tone all through, and a sound, healthy outlook for the future. Much the same applies to the engineering trades, where, with the exception that loom makers are rather quiet—some of them not running full time—all the principal branches are not only fully engaged, but in many cases have orders on their books that will carry them over the greater portion of the year.

During the past week there has perhaps been an absence of any special briskness in the iron market here, but a steady business has been coming forward, with deliveries on account of contracts freely taken, and, in fact, in quite as large quantity as either makers or manufacturers are able to meet, and prices exceedingly firm at the full current rates.

Barrow.—The hematite pig iron trade remains very steady, and prices are unchanged at 57s. to 58s. per ton for makers' iron at usual West Coast ports. In warrant iron the depression of a week ago has given way to an improvement, and a large speculative business has since been done, prices, which were down as low as 55s. 10½d., having improved to 57s. net cash sellers, 56s. 11½d. buyers. Makers are very fully employed. They have put an additional furnace in blast this week, and now are blowing 41 furnaces, as compared with a similar number in the corresponding week of last year. Stocks of warrant iron have been further increased this week by 1819 tons, and now stand at 173,547 tons, or 11,445 tons less than at the beginning of the year. It is quite expected from the movements in the market that stocks will further increase before the end of the year to a large extent.

Iron ore is in very brisk and active demand, and raisers are as busy as possible, but have not as much ore to dispose of as is in demand. Prices are very steady at 14s. for good ordinary sorts net at mines. Much prospecting is going on in the district, and a good find of ore is reported at Alcoats, in the Cleator district.

Steel makers are well off for orders, and report a very brisk demand for all classes of steel, but more particularly for shipbuilding material, which is in large and increasing consumption, and makers are being pushed to complete deliveries on old contracts, and are being offered new contracts of heavy tonnage. £6 17s. per ton is the quotation for heavy plates of ordinary specification, and £6 12s. is the price of angles. Orders are being given out for steel rails to a large extent, and prices are undisturbed at £4 12s. 6d. per ton net f.o.b. In billets, tin-bars, hoops, merchant steel, and heavy steel castings a good business is being done. The steel works at Barrow are closed for a fortnight for the holidays.

Shipbuilders are very busy, and marine engineers have a full programme of work on hand. They have tendered this week for further additions to the British Navy. Other tonnage is in smaller demand at present.

Coal and coke are in good demand, and full prices are ruling.

Shipping is very well employed at West Coast ports. The exports of pig iron last week were 7422 tons, and of steel 10,080 tons, as compared with 3910 tons of pig iron and 6350 tons of steel in the corresponding week of last year, showing an increase of 3512 tons of pig iron and 3730 tons of steel. The aggregate shipments for the year have totalled up to 503,894 tons of pig iron and 504,165 tons of steel, as compared with 420,089 tons of pig iron and 449,394 tons of steel in the corresponding period of last year, showing an increase of 83,805 tons of pig iron and 54,771 tons of steel.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THE year's work is quietly drawing to a close, and it finds the Yorkshire coal trade in a fairly satisfactory condition, with a cheerful outlook for 1899. When the figures for this year can be made up it will be found that the output of coal, in South Yorkshire particularly, has been largely in excess of the previous twelve months. With the demand slowly overtaking the supply, there has been a steady weeding out of unprofitable pits. Steam coal has risen about 1s. per ton on the year, and the twelvemonths gas contracts entered into in June last, were 1d. to 9d. per ton higher than the prices in June of 1897. It is a somewhat singular fact in connection with the gas-coal trade that the regular output of gas coal during the winter months is not equal to the demand. If it were not for the stocks in collieries and gasworks, the ordinary production would not be adequate for the requirements of the gas companies. At the beginning of the winter months last season stocks in South Yorkshire were exceptionally small, and there are indications that all the gasworks will not be able to obtain the coal they require. It has to be remembered, of course, that against the increase in the selling prices of coal has to be set the higher wages, the cost of the Workmen's Compensation Bill, and dearer colliery stores.

At the time of writing, house coal in best Silkstones is making 9s. to 9s. 9d. per ton; in some instances 10s. per ton. Ordinary qualities range from 7s. 6d. per ton. Barnsley house is steady from 8s. to 9s. per ton; seconds, from 7s. per ton. There is now a slight weakening in the export trade in steam coal, but the weight forwarded to the Humber ports is still in excess of the average in the closing month of the year. Large consumers, such as railway companies, are now negotiating for further supplies, for which it is expected an advance of 6d. to 1s. per ton will be given. Barnsley hards make from 8s. to 9s. per ton, seconds fetching 7s. per ton. Manufacturing fuel has kept in good demand during the larger part of the year, the textile and other industrial districts of Lancashire and Yorkshire being particularly active. Nuts are at 6s. 6d. to 7s. per ton; screened slack ranges from 5s. per ton; pit slack for coking purposes, 2s. 6d. to 3s. 6d. per ton. Coke keeps exceptionally firm, best washed fetching 11s. to 12s., and in some instances 13s. per ton, while ordinary is readily saleable at 9s. 6d. to 10s. and a little over.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE manufactured iron and steel industries of this district are exceptionally active; indeed, they have probably never been so fully employed at this season of the year, and in the case of steel it may safely be said that so large a production has never been reported at any other time. The pig iron market has apparently recovered from the reaction that followed the close of the recent "rig" in warrants, and is showing improvement; certainly more is being done than has been noticeable during the last four weeks, and prospects are very good. The ironfounding, engineering, and shipbuilding industries are also as brisk as they can well be, and there are to be extremely short holidays for Christmas and the New Year. If employers had their way, there would be none at all, for as a rule they are a good deal behind with the execution of their contracts, and their customers are pressing strongly for what they need. A couple of days at most are all that employers can afford to give, but a good many of the men are likely to take the greater part of the week, as they have been kept hard at it for months, and have worked a good deal of overtime, so that funds will not generally be lacking. Masters cannot well insist on regular working next week, because there is difficulty in getting plenty of hands now. There has been much complaint of late in the shipbuilding industry because of lost time, the men get such good wages that they can earn enough to satisfy them, in many cases, with three or four days' work per week, so that they are sometimes indifferent about working the full week, to the great inconvenience of the masters. The secretary of the men's association has several times of late in his periodical reports had to admonish them for the large amount of lost time that is reported.

It is satisfactory to note that consumers of pig iron are beginning to buy more freely for forward delivery, and that they will pay more for forward than for prompt delivery. The influence of the late "gamble" in warrants has pretty well disappeared, and has left the price of No. 3 Cleveland G.M.B. pig iron with a gain of something like 1s. 6d. per ton, as 42s. was the price when the "rig" set in at the beginning of October. Thus 1898 is closing with the price 2s. 6d. per ton above the average of the year, and 4s. 6d. above the minimum. This week consumers have been readily offering 44s. 3d. per ton for prompt f.o.b. deliveries of No. 3 Cleveland pig, but they would give 44s. 6d. for next quarter. These prices have been accepted, but generally makers have quoted 44s. 6d. for prompt, and 44s. 9d. to 45s. for next quarter. The fact that consumers will pay a premium for forward delivery is a very good indication.

No. 1 Cleveland pig iron has been quoted this week at 46s.; No. 4 foundry at 44s.; grey forge and mottled at 42s.; and white at 41s. 9d. per ton for early delivery. Forge qualities of pig iron are relatively cheaper than foundry, the reason being that while the latter are not readily obtainable, the supply of forge is in excess of requirements. Grey forge under ordinary circumstances is only 1s. per ton below No. 3, to-day it is 2s. 6d. cheaper, and as it costs almost the same to produce it, the makers are not well satisfied. There is a larger proportion of forge qualities made, and too little of foundry, the reason being that the furnaces are not working so well as in years past.

The demand for hematite pig iron is fair, and prices are decidedly stiffer, because producers are well off for orders, and also know that steel manufacturers are getting such good prices that they can afford to pay higher rates for their iron. Besides this the cost of production is increasing, as well because of dearer coke as of dearer ore. Consumers will readily pay 55s. per ton for mixed numbers, and some business has been done at this, but most of the makers quote 55s. 6d. for early delivery. They are buying Rubio ore more freely, as there is a probability of the duty on ore, proposed by the Spanish Government, being 10 per cent. *ad valorem*, and that would add 10d. per ton to the present price of the ore, thus increasing the cost of ore per ton of iron made to 1s. 8d. Merchants do not hesitate to enter into contracts for supplying ore, but they add a clause that the buyer is to pay any duty in excess of that at present levied.

Shipments of pig iron from the Cleveland district should improve, there being nothing now to interfere with them, the "rig" being over, and the weather open, so that supplies can be sent to the Continent. The quantity shipped this month to Wednesday night amounted to 54,027 tons, as compared with 60,418 tons last month, and 59,154 tons in December, 1897. Cleveland iron is still going more freely into the public warrant stores—more freely than was expected; on the 21st, Messrs. Connal and Co. held 133,501 tons, an increase of 9757 tons this month. Of hematite pig iron 34,419 tons were held, there being a decrease for the month of 2239 tons.

Prices of manufactured iron and steel are very favourable, and the year is closing with them at the highest, this being from 20s. to 25s. above the minimum for plates, bars, angles, and sheets, but rails have only gone up about 2s. 6d. The increases in prices have nearly all accrued during the second half of the year, and the quotations are now higher than they have been for years. No changes, however, from last week can be recorded.

The Central Marine Engineering Company this year have supplied engines for 29 vessels with 47,300 indicated horse-power, while in 1897 they supplied 22 vessels with 27,350 indicated horse-power, and in 1896, 18 vessels with 24,950 indicated horse-power. In the boiler department they constructed 60 boilers for the 29 vessels above referred to, and 15 other marine boilers of various classes, making altogether 75 marine boilers. The company have a large amount of work in hand for the coming year, including another of Mudd's patent five-crank engines, and a powerful set of twin-screw engines for an Atlantic liner. Sir Christopher Furness, Westgarth, and Co., at Middlesbrough, have constructed 20 sets of marine engines of 29,672 indicated horse-power, and various land engines of 2500 indicated horse-power in the aggregate; total, 32,172 indicated horse-power. These include engines for two Atlantic liners.

The Darlington Forge Company have just completed some very large steel castings for H.M.S. Venerable, now building at Chatham. They have supplied a cast steel ram which weighs 32 tons, in the casting of which 51 tons of steel were used; also two stern posts, each 14 tons, as well as two shaft brackets, each of 11½ tons, and a rudder weighing 18 tons. The company are enlarging their establishment, having bought the site of the Darlington Steel and Ironworks for extensions. New furnaces are now being constructed.

The coal trade is very active as far as regards deliveries, but it being so near the holidays buying is rather quiet. Where consumers or shippers have to buy steam coal for early delivery they have to pay 10s. 6d. for best, and 4s. 6d. for seconds, f.o.b. in each case. Best gas coals are about 9s. 6d., and seconds 8s. 9d. per ton f.o.b., and best bunker coals are at 8s. 9d. per ton f.o.b. The North-Eastern Railway Company's coal contracts for the next twelve months have been placed at 9s. per ton delivered into their wagons, this being 9d. per ton above the price they paid for this year. The average price of coke is 15s. 6d. per ton delivered at the furnaces. The old Adelaide Colliery, near Shildon, has been bought by Mr. R. A. Brown, of Darlington, and the pit, which has been idle for some years, is likely to be re-opened.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THE manufacturing branches of the Scotch iron trade are very well employed. In view of the holidays, which will call for some cessation of work, in connection with the New Year week at least, it may be said that there has been increased activity finishing up work that is urgently required to be done. But the pig iron market has been inactive. There has been little inquiry on the part of consumers, and speculators have had little inducement to participate in the business. With the market in this condition it has been difficult to maintain former prices. Indeed, the business done has been for the most part at lower rates.

Scotch warrants have sold from 49s. 7½d. to 49s. 11½d. cash, and 49s. 10½d. to 49s. 4½d. one month. In ordinary Cleveland iron there has been very little doing, the effect of the recent "corner" still preventing business being done. A few transactions only occurred in this class of iron from 45s. down to 44s. 5½d. one month, there being no demand for immediate delivery. Business took place in Cumberland hematite warrants at 57s. to 56s. 8d. cash, and 57s. 5d. to 57s. one month. There was practically nothing doing in Middlesbrough hematite warrants.

Hematite pigs have been in good demand, and the output of this class of iron is now greater than at any former time. Merchants quote 60s. 6d. per ton for delivery at the steel works, and the consumption is understood to be equal to the production, although as regards that some are inclined to have their doubts, after the surprise occasioned by the report of increased stocks in the North-West of England.

The prices of Scotch makers' pigs are steady, as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 50s. 1½d.; Nos. 3, 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 49s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Gartsherrie, No. 1, 56s.; No. 3, 51s.; Calder, No. 1, 57s.; No. 3, 51s.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Coltness, No. 1, 58s.;

No. 3, 51s. 6d.; Glengarnock, at Ardrossan, No. 1, 55s.; No. 3, 50s.; Eglinton, at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Dalmellington, at Ayr, No. 1, 51s. 6d.; No. 3, 50s.; Shotts at Leith, No. 1, 56s.; No. 3, 51s.; Carron, at Grangemouth, No. 1, 56s.; No. 3, 51s. per ton.

There are 48 furnaces making hematite, 30 ordinary, and four basic iron, the total of 82 thus in operation in Scotland comparing with 80 at this time last year.

The shipments of pig iron from Scottish ports in the past week amounted to 4601 tons, compared with 4189 in the same week of 1897. To South America 50 tons were despatched, India 170, Australia 150, France 405, Italy 185, Germany 60, Holland 215, Belgium 10, Spain 20, China and Japan 100, other countries 262; the coastwise shipments being 2974, against 2309 in the same week of 1897.

The finished iron and steel works are actively employed. They will be running full time, and in not a few cases doing overtime, till near the end of next week, the holidays beginning then instead of at Christmas. Prices of all goods are steady.

In the coal trade there has been continued activity, but much interruption to traffic. The recent block on the railways is still making its effect felt in the detention and reduction of the quantity of coals dealt with. This has been notably the case in the coal-shipping department, and the quantities despatched are less than they were at this time last year. The prices of coal are firmly maintained, owing to the difficulty of prompt delivery.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

THE year is coming to a close with undiminished vigour in all the leading industries. Coal is particularly brisk, and notable shipments are on the increase. The utmost energy is displayed in looking after the coaling stations, showing that preparedness for contingencies is constantly borne in mind. In the closing part of last week 5500 tons went to Colombo, 4100 to Port Said, and 5400 tons to Aden from Cardiff. Saturday was exceptionally brisk, 12,590 tons going to Port Said, and 9500 tons to Genoa. The demands of the Italian railways are well maintained, and the needs at Alexandria and Madeira well looked after. Nor again is there any falling off in consignments to France. On Saturday they were very large, St. Nazaire taking 7600 tons. Amongst the large shipments of this week from Cardiff have been 3800 tons to Colombo, 4000 tons to Port Said, another cargo of 3200 tons to Colombo, and 4000 tons to Suez.

House coal is steadily improving. The total coal shipments from Cardiff last week slightly exceeded 360,000 tons, or 30,000 tons in excess of the previous week. It is not at all improbable but that the rush to secure coal before the holiday season will bring totals up to close upon 400,000 tons from all the Cardiff ports. The Orient contract is one of the last that has been concluded. The agents in this were Dinham, Fawcens, and Co., London, the total 50,000 tons; it was secured by Lewis Navigation Company. Last week coal business was very brisk at Newport, Mon., foreign totalling up close upon 63,000 tons, and coastwise 18,963 tons. At Swansea there was similar gratifying activity, coal shipments nearly amounting to 50,000 tons, and patent fuel close to 12,000 tons. France, as usual, has been a considerable customer, Italy following, and being well imitated by Sweden and Germany. In respect of Cardiff port business I note a steady increase in vessels leaving for America in ballast. These are despatched from the States to England with cotton or grain, and simply touch at Cardiff for bunkering on return journey.

The seamen's agitation at Cardiff, Newport, and Swansea has, in the phraseology of the parties concerned, "fizzled out." There never was any vigour in the movement. Seamen, after the late stagnation, were only too glad of having vessels offered, and there never was any real difficulty in shipping a crew. On Friday last four steamers were rapidly served, the Enterprise, Recta, Angerton, and Drayton. Crews were obtained at the rate of £4 5s. to £4 10s. per month all round. In addition, a number of men were signed on to fill up vacancies in other vessels at £4.

Cardiff, like Swansea, continues a brisk trade in patent fuel, and some unusually good shipments of late have been recorded. One to Marseilles amounted to 2350 tons, and there were smaller ones to Norway and other destinations.

Prices of coal have not fluctuated much of late, the variations being at the most 3d. to 6d., and no difficulty has been experienced by leading coalowners in securing best prices for principal coal.

Closing figures at Cardiff this week were as follows:—Best steam, 12s. 9d. to 13s. 9d.; seconds, 11s. to 11s. 6d.; dry, 10s. 6d. to 10s. 9d.; best Monmouthshire, 10s. 9d. to 11s. 3d.; seconds, 9s. 3d. to 9s. 6d.; best steam, small, 6s. 3d. to 6s. 9d.; seconds, 4s. 9d. to 5s.; inferior sorts from 4s.; best house coal, 13s. to 14s.; No. 3 Rhondda, 12s. 6d. to 13s.; No. 2 Rhondda, 8s. 6d. to 9s. 6d. Swansea prices:—Anthracite, 14s. to 14s. 6d.; seconds, 12s. 6d. to 13s.; ordinary, 11s. to 11s. 6d.; small rubbly culm, according to portion of stem; steam, 11s. 6d. to 12s.; seconds, 9s. 6d. to 10s. 3d.; bunkers, 7s. 9d. to 8s. 3d.; small, 4s. 6d. to 5s. 9d.; house No. 3 Rhondda, 12s. to 13s.; No. 2 Rhondda, 9s. to 9s. 6d.; through, 7s. to 8s.; small, 5s. to 5s. 6d.

The iron and steel works show no signs of lessening prosperity. At all there is the fullest vigour, and the aim is stated in iron circles to clear off as much of the accumulations as possible, as it is certain that the new year will bring in a lot of new business. While home works are thus thoroughly occupied, it is no matter for surprise that some trade is of necessity, where urgency is great, sent abroad. It is currently reported that substantial orders have been given to America by the Midland Railway. At the same time home firms are not overlooked. Wales is doing good work for the Midlands. At one time it used to be a subject of comment that little or no engineering work was turned out in the Principality, and in the matter of manufactured iron even a bundle of nail rods had to be obtained from Bristol, though in the first instance sent by Welsh ironmasters. Lately some fine winding engines have been turned out, and recently large consignments of powerful machinery have been sent to India from Messrs. Taylor and Sons, Briton Ferry.

One noticeable feature of last week was the large importation of pig iron. Swansea received 1400 tons, and Newport largely, one consignment of 2010 tons coming from Middlesbrough, and another of 1300 tons from Barrow. Millom, Grimsby, Workington, and Ulverstone figured well. The importations of pig iron from Bilbao have been exceptional. Last week Ebbw Vale received 1060 tons, and Jones, Heard, 670. In addition Bilbao has been sending large supplies of ore to all the leading works, 5380 tons coming to Swansea. Duddon ore is also coming to the Upper Forest works.

On 'Change, Swansea, this week, it was a matter of comment that the pig iron market was recovering, Scotch showing 5d. a ton better, hematite about the same. Middlesbrough remains. It was stated that the consumption of pig iron in America had quite overtaken production, and that no imports here need be apprehended. The impression upon members is that this will strengthen the market, and make it firmer for all classes of iron in Wales. At present it was reported that the iron and steel market was strong, being materially influenced by the large amount of work in hand in shipbuilding, guns, &c., Welsh steel being in high repute, this is but to be expected from the extreme care taken in all details, from selection of ore to the analysis of the first "tap" from the furnace. Possibility of higher value is fairly assured.

At present closing prices, Swansea, were as follows:—Glasgow warrants, pig iron, 49s. 3d., 49s. 1½d. cash; Middlesbrough No. 3, 44s. 5½d. prompt, other numbers in proportion; Hematite warrants, 56s. 9d. for mixed; Cumberland, according to brand. Welsh bars, £6 7s. 6d. to £6 12s. 6d.; sheets iron and steel, £7 to £7 2s. 6d., with usual extras for higher gauges. Steel rails, heavy, £4 12s. 6d. to £4 15s.; light, £5 2s. 6d. to £5 12s. 6d.; Bessemer steel bars, £4 12s. 6d.; Siemens, best, £4 15s. Tin-plates, Bessemer steel cokes, 10s. 6d. to 10s. 9d.; Siemens, 10s. 9d. to 11s.; ternes, 19s. to 21s. 6d.; best charcoal, 12s. 9d. to 13s. Finished black plate, £8 10s. to £9; Canada, £7 2s. 6d. to £7 12s. 6d., delivered Swansea cash, less 3 and 1. Block tin, £82 7s. 6d. to £83. Lead, £13 5s.; Spanish, £13 2s. 6d. Iron ore in good demand. Tafna, 14s.; Rubio, 14s. 6d. Coke firm and in good request, at all ports.

There has been a considerable amount of business done in tin-plate, close upon 60,000 boxes being shipped at Swansea and 46,000 boxes brought into stock last week. Stocks are now at 203,085 boxes. Prices are still much below what they should be, considering the increased price of materials. Trouble is anticipated in labour questions with the new year, especially at Llanelly, where friction appears to be the normal element, and no amount of lost markets produce any effect in imparting common-sense views. The tin-platers at the Old Castle, Old Lodge, and Western are conceding a 15 per cent. reduction, but as in most other districts the concessions have been 22½ and 25, the men have been asked to re-consider. If they do not agree a stoppage is imminent. In the Swansea Valley, owing to a trifling dispute, two of the mills at the Foxhole Works were idle last week. The wash-house wage is to the front in the district, and employers point out that the reduction of a third is imperatively needed. Worcester Works are now busy. The mills at the Morriston and Midland were idle, but the prospects are now better, and both certain to be brisk next week.

In all quarters the output of steel has been great, and that of bars equally so, but not up to the demand. A good deal of local business is going on. Thus a large proportion of the bars turned out at the Duffryn is being worked up at Llantrissant and Maesteg.

The large Bessemer Works appear unaffected by the increased self-supplying capacity of tin-plate and auxiliary works, and the output of tin bars in addition to billets and rails is considerable.

The principal iron and steel consignments of the week have been to home districts, but Newport, Mon., despatched 700 tons rails to London, and 115 tons to Highbridge.

At Briton Ferry the output of hematite is very satisfactory. Six furnaces at the steelworks were in full operation last week, and the mills of the district were well occupied.

The improved state of the trade in the leading industries is giving a more hopeful condition to the railway and general stock and share list. This week there was a general improvement in prices for railway and colliery stock and shares, and not in a solitary case was there a fall. Barry Deferred changed hands at 41½, and Rhymney Preference advanced a point. Rhymney, Mon., shares, old and new, have gone up 6d., and the Mortgage Debentures ⅛, Tredegar iron and coal are firmer. Dry Dock shares are in better demand, and a further improvement is anticipated.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM coal shippers are well off for tonnage. Prices firm and an upward tendency. House coal is in good demand; prices remain same as last week. Steel and finished iron is in very good demand, and every prospect of advance in prices for coming year. Exports for week ending December 17th were:—Coal, foreign, 62,865 tons; coastwise, 18,963 tons. Imports for week ending December 20th were:—Pig iron, 4450 tons; iron ore, 5177 tons; manganese, 2400 tons; pitwood, 6429 tons; scrap, 445 tons; 190 tons cement.

Coal: Best steam, 11s. to 11s. 3d.; seconds, 10s.; house coal, best, 13s.; dock screenings, 6s. 6d.; colliery small, 5s. 3d. to 5s. 6d.; smith's coal, 7s. 6d. Pig iron: Scotch warrants, 49s. 3d.; hematite warrants, 57s. f.o.b. Cumberland; Middlesbrough No. 3, 44s. 4d. prompt. Iron ore: Rubio, 14s. 3d. prompt; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails, heavy sections, £4 12s. 6d. to £4 15s.; light ditto, £5 5s. to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s., all delivered in the district, cash. Tin-plates: Bessemer steel, coke, 10s. 6d. to 10s. 9d.; Siemens—coke finish—10s. 9d. to 11s. Pitwood, 18s. London Exchange Telegram: Copper, £55 12s. 6d.; Straits tin, £82 12s. 6d. Freights: Rather easier owing to the difficulty of arranging stems, on account of approaching holidays.

NOTES FROM GERMANY.

(From our own Correspondent.)

TRADE in the iron and allied industries over here continues to improve, and, owing to the increased demand that is experienced in most branches, the tendency of prices is all in an upward direction. In many departments makers are so heavily booked forward that it is exceptional where they can entertain new orders for delivery within the next eight or ten weeks. The engineering and bridge-building establishments are particularly active, and there is reason to believe that employment will become even more brisk in the New Year. At a recent tendering for bridge-building material in the Haag, the iron company Styrum, near Oberhausen, tendered lowest, and has consequently secured contracts for 41 bridges at 49,700fl., and 18 bridges at 64,700fl.

A very strong tone prevails throughout the pig iron markets of Rheinland-Westphalia and in Silesia, the greater part of production of third quarter in next year having already been sold. Activity at the rolling mills is, likewise, very brisk, and the last weeks of the year will, therefore, not be quiet, as they generally are, but, on the contrary, extremely busy, as consumers and dealers like to place orders at very short terms of delivery. Many articles are in much better request now than in autumn. In Silesia tubes, for instance, are in healthy demand now, while some time ago foreign competition prevented the inland works from doing much business. Heavy plates remain in very good call, and numerous orders from shipbuilding and engineering establishments are being secured, so that platemakers are entering the new year with plenty of work and fair prospects for the future. Sheets are less animated, but then winter is not a good time for that article, and spring will probably bring more orders. Prices are generally tending upwards, though but in a slight degree, and may, on the whole, be considered as rather low when the present strong position of most branches of the iron trade is considered. The Prussian State Railways have given out orders for 550 locomotives, which is a much larger number than was expected.

Last week's list quotations for raw and manufactured iron were:—Spiegeleisen, 10 to 12 p. c., M. 67 to 68; white forge pig, M. 58 to 60; German Bessemer, M. 68; basic, free place of consumption, M. 60; Luxemburg forge pig, M. 49·60; Luxemburg foundry pig, M. 52, free Luxemburg; German foundry pig No. 1, M. 68; No. 3, M. 62; German hematite, M. 68 per ton at works. Bars: M. 140 to 142; common plates in basic, M. 137·50 to 142·50; heavy plates for boiler-making purposes, M. 160 to 192·50, according to quality; sheets, M. 140 to 150, all per ton free at works.

The Austro-Hungarian iron business appears to be indulging in a sort of winter sleep, from which it will probably not awake till late in spring; the next weeks, or perhaps months, are not likely to bring any change, the raw and finished iron trades being all in a state of extreme dulness.

Crude iron, as well as the different sorts of manufactured iron, are meeting with very good demand on the Belgian iron market. Plates for export have been sold at 160f. p.t., merchant iron fetching, as a rule, 135f. p.t., though less has been offered and taken.

In coal and coke an exceptionally lively trade is done in Belgium, and a rise is expected to take place in the quotations for coal, those for coke having, to all appearance, reached the highest point, 18 to 23f. p.t. being quoted.

According to an official statement, given by the General Director of the Belgian Mining Department, the 256 collieries in Belgium have yielded in 1897 21,492,446 t., worth 220,672,100f., or 240,076 t. more than in the year before. Value per ton was 10·26f., or 0·75f. more than in previous year. Price of sale per ton was, on an average, 10·74f. Average depth of the coal mines is 472m. in the Hennegan, 285m. in the Namur district, and 333m. in the Liége district.

Producers of crude and finished iron are doing a satisfactory if not very large business in France; the general tone of quotations is reported as being firm.

PRICE OF GAS IN SOUTH LONDON.—It is announced that the directors of the South Metropolitan Gas Company, of which Mr. George Livesey is chairman, have decided to reduce the price of gas 1d. per 1000 cubic feet, making it 2s. 2d., as from Christmas, and to increase the quantity of gas sold by slot meters from 27 to 29 cubic feet for 1d. as soon as the 80,000 meters of this kind now in use in the company's district can be altered. When the previous reduction was made no concession could be allowed to the pre-payment consumers, owing to the large amount of work entailed for so small a reduction, but this is now more than made up, the additional quantity of gas to be given being equal to 2½d. per 1000 cubic feet.

MANCHESTER ASSOCIATION OF CIVIL ENGINEERING STUDENTS.—At a meeting of the Manchester Association of Students, in connection with the Institution of Civil Engineers, held on Wednesday last, Mr. A. H. Tyack read a paper on "Turbines," in the course of which he remarked that owing to their simplicity, compactness, and high speed, turbines were preferable to any kind of water motor. Classified according to the action of the water, turbines might be considered under the heads of "reaction wheels" and "impulse wheels." Sub-divided according to construction there were the radial flow, axial flow, and mixed flow wheels. Reaction wheels were particularly suited to low falls with constant and large volumes of water, whilst impulse wheels were more adapted to high heads and small volumes, or medium falls with largely varying volumes. Considering the various types of reaction wheels, Mr. Tyack described the Fourneyson as an example of the outward radial flow; the Vortex as an illustration of the inward radial flow; the Jonval as an axial flow motor, and the Victor turbine as an example of the mixed flow type. Impulse wheels, generally known as Girard turbines, were constructed on the inward flow principle for falls up to 60ft., but in higher falls, on the partial injection system. The Pelton wheel was the simplest form of water motor, resembling the ordinary water-wheel in form, but not suitable for falls under 100ft. It was very necessary to consider the circumstances for which a motor was required, and the conditions of the water supply, before choosing the turbine suitable to each particular case.

COAL IN KENT.—The second ordinary general meeting of the Kent Coal Syndicate was held on Wednesday at the Cannon-street Hotel. Mr. C. H. Tindal presided, and moved the adoption of the report. He said they had not yet developed any considerable results, and up to the present those achieved were incomplete and inconclusive. As regarded the Kent coal enterprise generally, and the manner in which it was going on at Dover and elsewhere, he thought he might say that there was no doubt that at Dover they would obtain coal within a measurable distance of time—he supposed in the course of a few months. Mr. W. J. Cousins, in seconding the resolution, remarked that the various companies with which he was connected had enabled him to become thoroughly acquainted with the whole of the borings. As regarded the Penshurst boring, the progress had been delayed during several months, but the work had been recommenced, and the boring was now proceeding satisfactorily. At the present time that shaft had been sunk down to 1511ft. The Pluckley boring, which was stopped for the considerable period of ten months, from the same difficulties which were met with in the case of the Penshurst bore, was recommenced about three weeks ago, and at the time of restarting the depth which had been reached was 815ft. They were now down 850ft., which was very good progress, and he trusted that within a short period they would be able to make the same rate of progress in the Penshurst boring. Having given particulars of the other borings in Kent, he stated that the cores at Ropersole were coming up quite straight, there was no dip. At Dover there was a very slight dip. The indications at Ropersole were practically the same as at Dover.

MEDITERRANEAN AND PERSIAN GULF RAILWAY.—It is stated that the scheme for uniting the Mediterranean with the Persian Gulf by a railway from Tripoli to Koweyt, which has been under consideration by the Sultan and the Sublime Porte for some time, meets with favour in both instances. According to the *Times'* Vienna correspondent, the application for the concession has been made by Count Vladimir Kapnist, in the name of an international syndicate. It is proposed to build a main trunk line from Tripoli, on the Mediterranean, to Koweyt, on the Persian Gulf, and to establish ports and harbours at each terminus; as also a branch line from Khanikin, on the Persian frontier, to Kerbela and to Nedjef—*vid* Bagdad and Musseyib, on the Euphrates. Preferential rights for the construction and exploitation of a series of branch railways are included in the project, as also the exclusive right to establish landing-stages and wharves on the rivers, and bonded warehouses and goods depôts in the stations and towns traversed by the railway. Other rights are included in the concession, such as those of draining and irrigating large extents of territory, and of working all mines, petroleum wells, bitumen and salt deposits not yet conceded, within fifty kilometres on each side of the line. The report estimates that, without diminishing to any great extent the receipts of the Suez Canal, the shortening of the journey between Europe and the East would create and develop a through traffic for passengers and mails, and for lighter and more valuable articles of merchandise. In the opinion of the chief engineer the two terminus ports—namely, Tripoli and Koweyt—could easily be made safe and commodious for almost any number of vessels of the largest tonnage; and the sea journey to the East by this route would thereby be rendered the shortest possible, and would be free from the many dangers and inconveniences which are encountered in the present transit through the Red Sea and the Arabian Gulf. The report goes on to say that from Tripoli the line would follow the sea coast as far as the Nahr-el-Kebir, and then up the course of that river over the lowest and easiest pass which could be found through the chain of mountains running parallel to the Syrian coast. The line would reach a summit level of about 2000ft. above the sea between Tripoli and Homs, on a plateau of hard black basalt. Thence it would proceed to Homs, which is about 1500ft. above the sea, and on through Palmyra, past numerous villages to Rahaba, on the Euphrates, following, in the main, the present caravan route. The railway would go down the valley of the Euphrates as far as El Kaim, then over the plains to Hit, where it would cross the river and proceed to Iskanderieh, the junction for Bagdad and for Khanikin—on the Persian frontier—and to Kerbela and Nedjef, the famous shrines and burial-places of the Persian Mahomedans, on the south; thence, in as nearly a straight line as possible, across the great alluvial plain between the two rivers to Kurna, where it would again cross the Euphrates and be continued to Basra, and thence across country to Koweyt, on the Persian Gulf.

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

MANUFACTURERS of refrigerating plant are afforded an opportunity just now in South Africa which they should be eager to embrace. The combined effect of the drought and the rinderpest which have lately afflicted the country has been so severe upon South Africa's flocks and herds that at the present moment a positive famine is threatened in meat. There is a consequent rush to erect cold storage plants, and the various Governments are actually being called upon to apply public funds to this purpose. A Bill is now before the Parliament of the Cape Colony enabling local authorities to erect cold storage plant, the Government advancing the money out of the Public Loan Act. It is also understood that the Cape Government Railways is about to introduce a greatly improved service of refrigerator cars.

The unsatisfactory system upon which municipal works are undertaken in the Transvaal has received another illustration. Recently the Johannesburg Town Council attempted to raise a loan of £150,000 for the extension of its electric lighting plant, and was unable to obtain the money. Now it is stated that that body has approached the famous German engineering firm of Siemens and Halske, which already possesses a contract for part of the lighting of the town, with a view to obtaining the necessary funds. The impropriety of a public body borrowing money off its own contractors is a point which needs no insisting upon, but the incident is certainly a striking illustration of the energy and astuteness which German engineering firms show in cultivating trade in foreign markets.

The commercial community in Capetown is asking that half a million should be spent upon the construction of a new railway station at Capetown. This expenditure the Railway Department is not prepared to incur, but it is proposed to spend £25,000 on the station between now and next session, and a further outlay will be made in the following session.

No decision has yet been arrived at with respect to the loan which the Transvaal Government is endeavouring to raise in order to carry out railway and other public works. Two offers have been submitted to the Pretoria authorities, but one was considered too severe as to terms of interest, while the other stipulated that the lenders should be given the contracts for the construction of the Pretoria-Rustenburg and Belfast-Lydenburg railways. The Volksraad has rejected these proposals, and has instructed the Government to raise a loan of two and a-half millions, without entering into any engagements with respect to railway concessions. It is practically certain that the loan will be placed with continental capitalists, and that all the engineering plant and material upon which it will be expended will be obtained in Germany or Holland.

Business is not particularly brisk in engineering and mining stores on the Witwatersrand, and bitter complaint is made, both of the mines' system of local buying, and of the growing practice of importing supplies direct from manufacturers in Europe and the States. On the other hand, trade is reported excellent in Rhodesia. Two new ironfoundries have lately been started in the neighbourhood of Johannesburg, and the local engineering industry is certainly advancing.

A compressor of unusual capacity—thirty-six drills—is under order for the New Modderfontein Company, where the new mill engine is also to be of the exceptional size of 1000-horse power. The compressor is of the King-Riedler Company, which is in great favour amongst Witwatersrand mine managers.

AMERICAN NOTES.

(From our own Correspondent.)

NEW YORK, December 10th.

THE latest reports throughout the interior concerning movements in iron and steel reveal anxiety among certain buyers to guard themselves against an advance during the winter, which many regard as probable. Steel rail contracts are being snatched up by agents of Pittsburgh mills at 17 dollars or less, and there is quite a scramble among the Pennsylvania mills for work. A good deal of business, amounting at least to 500,000 tons, was provisionally done during the progress of negotiations, and when they failed the business was announced. Contracts for over one hundred thousand tons are now in the balance.

Old rail buyers are making strong bids for large supplies of old iron rails. The Lakes are closed and business by water is practically over. Railway freight traffic is heavy and rates on some classes have been advanced. The holiday season is at hand, and for the present iron and steel orders will be at a minimum. Bar iron makers will end the year with more contract work to enter the new year with than ever before. The strong basis for this demand is the call for car-building iron. Boiler-plate and tank iron have been unusually active, and within a week small shop managers have been asking for quotations on January deliveries. Bridge builders enter the winter season with their hands full of work, but it will slack up late in January, except on a few big jobs that are to be leisurely prosecuted. In a general way pig iron is stronger, because of the clearer comprehension of the fact that the production is not far enough ahead of demand to make it safe. The Bessemer Pig Association is working well, and the Tinplate Association has absolute control. The rail makers could have sold their product higher, but a unification of interests has been made a practical impossibility by reason of the economic advantages which Pittsburgh interests have secured through ownership of ore mines, coal mines, coke plants, Lake transportation, and rail deliveries. There is a feeling in the trade that surprising developments may be expected.

The improving traffic condition and the practically positive assurances of a great relative increase next year over this are the grounds for the remarkable expansion of demand for steel rails, locomotives, cars, and railway equipment generally. The latest railroad figures are these:—The gross earnings of 119 roads in November increased 2,187,476 dols., or 4·58 per cent., or 21 per cent. over same month last year. These roads have a mileage of 93,621 miles. For eleven months to November 30th, the increase in gross earnings on 119 roads was 39,464,378 dols., against an increase of 30,884,222 dols. same time last year, or over 70,000,000 dols. in two years. The excess of exports for three years furnishes, in one sense, an additional capital of 1,000,000,000 dols., which is a safe basis for credit to two or three times that amount. The savings banks are lowering their rate of interest, and this will induce many depositors to withdraw their money for some other form of investment, and thus stimulate trade. This points to the possibility of a large number of what are termed in the States "wild cat" schemes. Hence investors must be doubly careful. The iron trade is gaining strength every week. Prices are threatening to advance. Pig iron production is barely equal now to demand. Makers look with concern on the foreign demand, which from their standpoint will be heavy. There are many orders coming in for transatlantic delivery. Furnace capacity is being engaged ahead. The same is also true of other iron and steel products. Steel rails are also in active demand at 17 dols. at Pittsburgh, and 18 dols. at Chicago. A great many roads have not yet ordered. January will be an eventful month in the way of forming the policy for the coming year. Plate mills are oversold, and Australia is calling for 75,000 to 85,000 tons, of which nearly one-half have just been placed under contract. All lines are active, and business is increasing. The tin-plate combination is perfected. Other lesser combinations are under way.

LAUNCHES AND TRIAL TRIPS.

MALANG, steel screw steamer; built by, Messrs. Wigham Richardson and Co.; to the order of, Rotterdamsche Lloyd; dimensions, 333ft. by 44ft. 2in.; trial trip, December 12th; 11¼ knots.

RECOVERY, special service; built by, Messrs. Wm. Simons and Co., Limited; to the order of, The British Admiralty; for use in connection with Plymouth breakwater. Fitted with three lines of rails for conveyance of sixteen trucks, loaded with stones. She has also sheer legs and 20-ton crane complete; launch, December 13th.

CLAVERDALE, spar-decked, screw steamer; built by, Thornaby Shipbuilding Yard; to the order of, Messrs. E. H. Haslekust and Co.; dimensions, 341ft., 45ft., 28ft. 6in. moulded; to carry, 5500 tons deadweight; engines, triple-expansion, 24in., 38in., 64in. by 42in., pressure 160 lb.; constructed by, Messrs. Thomas Richardson and Sons, Limited; launch, December 15th.

BERGENHUS; built by, Messrs. Irvine's Shipbuilding and Dry Docks Company, Limited; to the order of, Captain Andreas Olsen, of Bergen; dimensions, 352ft., 48ft., 27ft. 9in.; engines, triple-expansion, 25in., 40in., 66in. by 45in., pressure 160 lb.; constructed by, Central Marine Engine Works.

ALEXANDER GOLOVATCHEFF, barge-loading dredger; built by, Messrs. Wm. Simons and Co., Limited; to the order of, The Russian Government; launch, December 16th.

MILES COVERDALE; built by, Messrs. Wm. Gray and Co., Limited; to the order of, Messrs. John Coverdale and Son; dimensions, 312ft., 43ft., 22ft. 3½in.; engines, triple-expansion, 22in., 35in., 59in. by 39in., pressure 170 lb.; trial trip, December 20th.

TRADE AND BUSINESS ANNOUNCEMENTS.—Messrs. Bell, Thompson, and Co. inform us that they have been appointed agents for The Tyne Brass and Copper Tube Manufacturing Company, Jarrow-on-Tyne.—Messrs. Alfred Dickinson and Co. have now removed from Colmore-row, and taken offices in the Telephone-buildings, Newhall-street, Birmingham.—The Horsfall Furnace Syndicate, Limited, has established a London office, at 36, Great George-street, Westminster, in charge of Mr. Somerset Butler.—We are requested to state that the offices of *Locomotive Engineering*, a New York journal, were entirely destroyed by fire, and everything, including the mailing list, is lost. The publishers ask their subscribers to send their name, address, and date of expiration.—Messrs. Bell, Thompson, and Co. have been appointed agents for Liverpool district for Messrs. Wilkinson and Co., Dudley.—Several Lancashire towns have ordered steam fire engines of Merryweather's "Gem" type.

ASSOCIATION OF BIRMINGHAM STUDENTS OF THE INSTITUTION OF CIVIL ENGINEERS.—At the last meeting Mr. H. R. Thomas, B.Sc., Stud. Inst. C.E., read a paper on "Axles for Road Carriages and Motor Cars, and their Manufacture." In discussing ball bearings, the author considered they were not applicable to cart and carriage axles, as it is very difficult to properly harden the large bearings necessary, and either the balls or the races would crush under the excessive weight. Roller bearings have a great future before them, as in this case the rollers run the whole length of the axle. Faggoted axles are the best, as should there be a flaw in any one piece of iron, it would not materially affect the strength of the axle. In designing axles, the author usually allows a factor of safety of 8 or 9, in view of the many various strains which come upon it. "Foregathering," that is, inclining the arm forward, which is supposed to cause the wheel to run against the collar instead of the nut, interferes with the free running of the vehicle, and is therefore not recommended. The resignation of Mr. Henry C. Adams, after five years' service as honorary secretary, was accepted, and Mr. G. T. Phelps, B.A., Stud. Inst. C.E., was appointed in his stead.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

*** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

8th December, 1898.

25,923. CONSTRUCTION of SCARVES, &c., H. Thomson, London.
25,924. PROJECTING MOVING OBJECTS, T. W. Barber, London.
25,925. HYPOCHLORITE of SODA. M. Muspratt, E. S. Smith, and the United Alkali Company, Limited, London.
25,926. PURIFIERS for STEAM GENERATORS, T. Sugden, London.
25,927. PENS, G. Varley, London.
25,928. FASTENING for LABELS and TAGS, J. Proctor, London.
25,929. SHIRT CUFFS, W. H. Yearron and J. H. Fox, London.
25,930. TAKING BEARINGS, A. J. Boult.—(*C. Solmond, United States.*)
25,931. BRIDGES, C. Horton and C. H. Bradley, London.
25,932. COAT and VEST HOLDERS, D. W. Axene, London.
25,933. PADDLE-WHEELS for VESSELS, J. S. Terrell, London.
25,934. RAIL-CLAMPS, J. M. Henigan and C. W. Watt, London.
25,935. NON-REFILLABLE BOTTLES, J. Merigan, London.
25,936. NON-REFILLABLE BOTTLES, A. M. Legrand, London.
25,937. MAIL POUCHES, S. C. and J. E. Reese, London.
25,938. TROLLEYS, O. W. Swanson, London.
25,939. LABEL HOLDER for LUGGAGE, C. R. Mitchell, London.
25,940. SADDLE CLIPS for CYCLES, H. Mills, Birmingham.
25,941. ADVERTISING, P. A Ganacheau and L. Gamotot, London.
25,942. SHIPS' BERTHS, C. Johnson and W. Griffin, Birmingham.
25,943. PROTECTING GLAZED BRICKS, &c., J. Webb, London.
25,944. TRUSSES, S. A. D. Hardy, London.
25,945. COMPOSITION for PAVING BLOCKS, W. H. Coward, London.
25,946. ACETYLENE GAS GENERATORS, H. C. Hill, Manchester
25,947. CYLINDERS for PRINTING MACHINES, F. Frisch, London.
25,948. CYLINDERS of VERTICAL MOTORS, A. R. Lucas, London.
25,949. TIRES for VELOCIPEDE WHEELS, A. Drucker, London.
25,950. FOG HORNS, A. Camilleri, London.
25,951. CIGARETTE-MAKING MACHINE, G. F. Zimmer, London.
25,952. BOLTING MILLS, SCREENS, &c., H. Dietz, London.
25,953. STENCILLING MACHINE, P. Jensen.—(*F. E. Clark, United States.*)
25,954. COVERINGS for CYCLE HANDLES, A. H. Gladwin, London.
25,955. DYNAMOMETERS, W. P. Thompson.—(*H. S. Elworthy, Russia.*)
25,956. MANUFACTURE of OATCAKE, R. H. Clarkson, Liverpool.
25,957. BUSKS, W. H. Cooper and G. E. Gather, Liverpool.
25,958. TOY, J. Robinson, Manchester.
25,959. JAWED CHUCKS, C. and G. B. Taylor, Birmingham.
25,960. ANNEALING MUFFLE FURNACE, W. G. Moore, Birmingham.
25,961. BRACKETS for ELECTRIC CONDUCTORS, C. Pellenz, London.
25,962. HYPOCHLORATES of ALKALIES, E. S. Smith, and The United Alkali Company, Limited, London.
25,963. HYPOCHLORATES of ALKALIES, C. L. Higgins, M. Muspratt, E. S. Smith, and The United Alkali Company, Limited, London.
25,964. COLOURING MATTERS, G. W. Johnson.—(*Kalle and Co., Germany.*)
25,965. COLOURING MATTERS, G. W. Johnson.—(*Kalle and Co., Germany.*)
25,966. INDIGO, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
25,967. STOVES, G. T. Epstein, Bristol.
25,968. ACETYLENE-STORING APPARATUS, G. M. A. Claude, London.
25,969. ROLLER BEARINGS, J. A. W. O'N. Torrens, London.
25,970. ORNAMENTAL FABRICS, A. Briggs, London.
25,971. APPARATUS for STERILISING, A. S. Barham, London.
25,972. DRIVING MOTOR CARS, A. F. Spooner.—(*H. Baudry, France.*)
25,973. ANIMAL FOOD, C. Jung, A. Brecher, and A. Kittel, London.
25,974. MANUFACTURING CIDER, J. Imray.—(*La Société Anonyme des Matières Colorantes et produits Chimiques de St. Denis and D. A. Rosenstiehl, France.*)
25,975. CYCLES, G. W. Manson, London.
25,976. SPOONS, W. Evans, London.
25,977. WATER-TUBE BOILERS, H. Blessingen, London.
25,978. APPARATUS for STRINGING PEARLS, L. Dosch, London.
25,979. TREATING ORES, F. W. Martino and F. Stubbs, London.
25,980. VALVE GEAR for STEAM ENGINES, J. Damics, London.
25,981. TUBES, W. H. Beck.—(*C. Blévy, France.*)
25,982. INCANDESCENT GAS BURNERS, H. P. Salsbury, London.
25,983. EXTRACTION of PRECIOUS METALS, A. Lavoix, London.
25,984. EXPLOSION MOTORS, P. Pichard, London.
25,985. METHOD of ELECTRIC IGNITION, P. Pichard, London.
25,986. AUTOMATIC BRAKE for VEHICLES, J. Martin, London.
25,987. FRAMING for CANDLE HOLDERS, C. E. Green, London.
25,988. PUMPS, J. Gwynne and E. W. Sargeant, London.
25,989. COIN-FREED APPARATUS, S. Landsberger, London.
25,990. NON-REFILLABLE BOTTLES, W. Creasy, London.
25,991. JAM, E. G. Scott, London.
25,992. WATER HEATERS, G. A. Perram, London.

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25,993. BED RESTS, E. G. Payne, London.
25,994. RACKS for DRYING CLOTHES, J. G. Hicks, Sheffield.
25,995. DETACHABLE MUDGUARD, F. W. Thompstone, Salford.
25,996. BRACKET for COAT HOOKS, R. Beckett, Shrewsbury.
25,997. ACETYLENE GENERATOR, H. Jellett, Dublin.
25,998. TOYS, G. F. Lüttickе, Berlin.
25,999. MATTRESS FRAME, W. Rankin.—(*E. Woodbury, Cuba.*)
26,000. BACHELOR'S FRIEND, F. G. N. Mills and C. F. Hirth, London.
26,001. BRACKET for TRAWL OTTER BOARDS, R. W. Lewis, Aberdeen.
26,002. PNEUMATIC TIRES, J. G. Surman, Healing, Lincolnshire.
26,003. LAYING PLANKS on SHIPS' DECKS, T. Wallace, Manchester.
26,004. DOOL used in MAKING WHEELS, S. Newland, London.
26,005. PNEUMATIC LEG GUARD, W. R. J. Forsyth, Folkstone, Kent.
26,006. WINDOW-SASH FASTENER, N. J. Butler and T. Minty, Brighton.
26,007. LOCOMOTIVES, W. Simpson, W. L. Bodman, and D. H. Simpson, Manchester.
26,008. COUPLINGS, W. Simpson, W. L. Bodman, and D. H. Simpson, Manchester.
26,009. TIE-HOLDING COLLARS, M. B. Kendrick, Glasgow.
26,010. ARTIFICIAL IVORY, J. A. Boden, London.
26,011. LIGHTING LAMPS, R. J. Urquhart.—(*R. Rete-Meyer, Germany.*)
26,012. TRAVELLING CARDING ENGINES, R. Taylor, jun., Manchester.
26,013. DRAWING FRAMES, J. McQueen and D. Barker, Manchester.
26,014. ELECTRIC STOP MOTION for DRAWING FRAMES J. McQueen and D. Barker, Manchester.
26,015. SPRING FOLK for CARRYING BICYCLES, P. G Ebbutt, Birmingham.
26,016. PRINTING MACHINES, F. Shaw and J. D. Athey, Stockton-on-Tees.
26,017. GAME, L. M. Gibson, Birmingham.
26,018. PORTABLE GAS HOLDERS, A. G. Adamson, Glasgow.
26,019. VALVE UNION for WATER COCKS, H. Crane, jun., Birmingham.
26,020. ELECTRIC SWITCHES, H. W. Cox, Nottingham.
26,021. BUSK for CORSETS, L. M. Silverwood, Eastleigh, Hants.
26,022. DISC WHEELS for RAILWAY VEHICLES, J. Baker, Sheffield.
26,023. "REVOLUTION" INDICATORS, J. H. Gibson, Liverpool.
26,024. TUBULAR POLES, W. W. Richardson, Halifax.
26,025. TAPERED TUBES, W. W. Richardson, Halifax.
26,026. GALVANIC BATTERIES, W. G. Heys — (*S. Silberberg, United States.*)
26,027. TOY TEAPOT, A. E. Halks, London.
26,028. INTERNALLY-STOPPERED BOTTLES, A. E. Baldock, Birmingham.
26,029. FRAMES for VELOCIPEDES, T. B. Sharp, Birmingham.
26,030. PORTABLE TANKS for OIL, G. W. Gooding, London.
26,031. LOCKS for KNITTING MACHINES, H. Donner London.
26,032. WHEEL TIRES, T. W. Jones, London.
26,033. CONNECTOR for ELECTRIC WIRES, H. W. Miller, W. Turvey, and G. C. Weston, London.
26,034. ANTI-VIBRATOR GAS FITTING, J. B. Colbran, London.
26,035. CHAFF-CUTTING MACHINES, J. Walker, London.
26,036. CYCLE and VEHICLE BRAKES, F. Beauchamp, London.
26,037. REMOVING HUSKS from GRAIN, P. Rakhmanoff, London.
26,038. ELECTRICALLY OPERATING CLOCKS, W. B. Buer, T. W. Legge, and J. Tabrar, London.
26,039. WATER-TUBE BOILERS, J. S. and J. L. White, and A. Forster, London.
26,040. POCKET FOLDING SCREW WRENCHES, C. Bach, London.
26,041. HOLDFAST PIN for DRYING GROUNDS, A. Stromberg, London.
26,042. GAME, J. Klauder, London.
26,043. LEARNING MUSICAL SCALES, H. Woolley, London.
26,044. HORN BUTTONS, C. Franze, London.
26,045. ATTACHING INFLATORS to CYCLES, W. G. Hurst, London.
26,046. ROTARY ENGINES, W. H. Bond, Kingston-on-Thames.
26,047. RIDING ATTACHMENT for AGRICULTURAL IMPLEMENTS, G. W. Babcock, W. H. Clark, and W. W. Redman, Kingston-on-Thames.
26,048. SECURING PUMP to BICYCLE, R. W. Smith, Birmingham.
26,049. BALL BOTTLE STOPPERS, J. Seyboldt, London.
26,050. CORNICE POLES for WINDOWS, J. Snuggs, London.
26,051. TOY, J. T. Lawrence, London.
26,052. PREVENTING BOTTLE RE-FILLING, G. H. Joner, London.
26,053. WATER GAUGES, G. H. Jones, London.
26,054. BALL and ROLLER BEARINGS, J. Yeomans, London.
26,055. STERILISING APPARATUS, T. F. A. Leclerc, London.
26,056. COIN-FREED APPARATUS, E. P. Riessner, London.
26,057. DRYING APPARATUS, W. P. Thompson.—(*P. J. Rosca, Germany.*)
26,058. WAGONS, R. Gill, Liverpool.
26,059. OXIDES, C. S. Bradley and C. B. Jacobs, Liverpool.
26,060. SOLUBLE SALTS, C. S. Bradley and C. B. Jacobs, Liverpool.
26,061. ANTHRACENE, C. S. Bradley and C. B. Jacobs, Liverpool.
26,062. POLISHING or GLAZING LEATHER, F. Breidenbach, Manchester.
26,063. SWITCHBOARD for USE with SIGNS, W. A. Gent, Birmingham.
26,064. INSERTING MATTER in PRINTING PLATES, J. Cowley, London.
26,065. HEATING WATER, Maiche, Limited.—(*L. Maiche, France.*)
26,066. BROWN POLYAZO DYESTUFFS, O. Imray.—(*The Farbwerke vormals Meister, Lucius, and Brüning, Germany.*)
26,067. ELECTRIC LAMP, H. C. Gover and C. F Proctor, London.
26,068. GLOW LAMPS, Siemens Brothers and Co, Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
26,069. TWO-WHEELED VEHICLES, W. Dickson, London.
26,070. PRODUCING PRINTED MATTER, J. F. Duke, London.
26,071. METAL BOXES, F. A. Walker and J. Baker, London.
26,072. PERAMBULATORS and MAIL CARTS, J. Ashton, London.
26,073. TRANSMITTING ELECTRICAL ENERGY, A. F. Hills, London.
26,074. ELECTRO-MOTORS, A. F. Hills, London.
26,075. FERRIES, A. F. Hills, London.
26,076. EXPLOSION ENGINES, R. Edwards, London.
26,077. CASH TILLS, H. Davidson, London.
26,078. ADVERTISING APPARATUS, R. von Scharrenhorn, London.
26,079. CYCLES, R. E. Phillips, London.
26,080. WRINGING MACHINES, J. H. and T. B. King, London.
26,081. SHELLS for HIGH EXPLOSIVES, L. Gathmann, London.
26,082. WORKMEN'S TIME RECORDERS, W. le G. Bundy, London.
26,083. TENT POLES, G. F. Beyts, London.
26,084. MACHINES for CUTTING CHAFF, A. Dyball, London.
26,085. EXHIBITING MOVING PICTURES, C. Raleigh, London.
26,086. MEANS for GRINDING TOOLS, N. Dedrick, London.
26,087. A CLIP for RAZOR STROPS, &c., J. Pepper, London.
26,088. CEMENTS, D. M. Sutherland, London.
26,089. ORNAMENTS, W. Sanders and G. E. Seymour, London.
26,090. CYCLE TIRES, E. Apperly, Stroud, Gloucestershire.

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26,091. MACHINES for CASTING TYPE, H. E. Moul, London.
26,092. ARMATURES for DYNAMOS, A. G. G. Cumming, Leith, Scotland.

26,093. CLEANING LATEX, T. Christy.—(*J. H. Hart, Trinidad.*)
26,094. BRAKES for BICYCLES, G. A. Parkin, Shotton, Flintshire.
26,095. APPLIANCE for FASTENING BOOTS, A. Marshall, Bristol.
26,096. BRAKE, H Filmer, London.
26,097. CLEANING the INTERIOR of PIPES, G. F. Restall, London.
26,098. SPANNER, S. P. Bowen, G. Graham, and W. Smith, Middlesbrough.
26,099. MEANS for PRODUCING PATTERNS, O. St. L. Davies, Manchester.
26,100. ADVERTISING TOY, W. H. C. D. Charity, Manchester.
26,101. BOTTLE STOPPERS, E. Scholes, Manchester.
26,102. CYCLE FORKS, J. B. Dunlop and J. B. Dunlop, jun., Dublin.
26,103. PRESS for MAKING GOLF BALLS, W. H. Smith, Bradford.
26,104. FIRE-ESCAPES, W. and J. Jack, Glasgow.
26,105. VALVES for PNEUMATIC TIRES, J. F. Brown, Manchester.
26,106. SAFETY LAMPS for MINERS, A. Howat, Manchester.
26,107. FLEXIBLE LADDERS, J. Hargreaves, Farnworth-in-Widnes, Lancs.
26,108. MANURE-DISTRIBUTING DEVICE, J. F. Witthold, Glasgow.
26,109. OPERATING BOLTS, A. Brown and H. C. Pruce, Birmingham.
26,110. FASTENING STAIR RODS, W. J. and T. Dobbs, Wolverhampton.
26,111. CORS, T. Perry and Son, Limited, and H. Garner, Wolverhampton.
26,112. RIVETS, J. W. Wailes, Liverpool.
26,113. MAIL CARTS, The Perambulator Manufacturing Company, Limited, Birmingham.
26,114. BRAKES for BICYCLES, J. Mills and G. Jepson, Sheffield.
26,115. SASH WINDOW FRAMES, C. W. Davenport, Manchester.
26,116. GALVANIC BATTERIES, W. G. Heys.—(*s. Silberberg, United States.*)
26,117. PORTABLE SANITARY URINAL, H. J. Barratt, Canterbury.
26,118. MOWING MACHINE FRAMES, A. C. Artor, Canterbury.
26,119. CYCLE TIRES, J. Telford, Maryport, Cumberland.
26,120. WOOD-BORING MACHINES, J. Whittle, Manchester.
26,121. PASTE for STATIONERY PURPOSES, J. H. Bignell, London.
26,122. ENVELOPES, E. M. M. Whitehouse, Birmingham.
26,123 PRODUCING PURE LEAD OXIDE, R. Bayer, London.
26,124. STEAM GENERATOR, J. Judge, Newcastle-on-Tyne.
26,125. COIN-FREED APPARATUS, T. Harrison, Newcastle-on-Tyne.
26,126. ACTION for PENCILS, E. Murrle.—(*O. Ungleuk, Germany.*)
26,127. CLIP for PUMPS of BICYCLES, &c., A. Rose, London.
26,128. MACHINE for SAWING STONE, E. Rhodes, London.
26,129. FLUSHING APPARATUS, H. F. Standing and C. F. Dixon, London.
26,130. MACHINE for WASHING WOOL, H. C. Longsdon, Keighley.
26,131. SUPPLYING AIR to CYLINDERS, T. W. Marshall, London.
26,132. SHARPENER for SCISSORS, C. H. Marshall, London.
26,133. HANDLE BARS for VELOCIPEDES, D. N. Thomas, London.
26,134. OBTAINING HIGH TEMPERATURES, F. J. Bergmann, London.
26,135. TREATMENT of RAISINS, J. G. Gibson, Liverpool.
26,136. ELECTRICAL MEASURING INSTRUMENT, K. Lehner, Liverpool.
26,137. BROOCH FASTENINGS, A. R. Connop, London.
26,138. COMBINED DEVICE for HOLDING GOODS, G. Eastwood, London.
26,139. FASTENERS for GATES, W. N. Rowell and A. Bell, London.
26,140. PHOTOGRAPHIC CAMERAS, T. E. Meadowcroft, London.
26,141. WASHING COKE, J. E. and E. L. Joselin and M. B. Wild, London.
26,142. LOOMS for WEAVING, F. W. and B. Franklin and J. Clarke, Birmingham.
26,143. SCAFFOLDING, P. T. L. Toelpe, London.
26,144. PROPELLING VELOCIPEDES, A. H. P. Blunt, London.
26,145. CONTINUOUS-CURRENT DYNAMOS, A. O. Berry, London.
26,146. KNIFE SHARPENER, J. Smith, London.
26,147. TOOL-GRINDING APPLIANCE, H. S. Ilsley, London.
26,148. MECHANISM for TRANSMISSION of POWER, A. M. Craig, London.
26,149. REGULATING the POSITION of PROJECTILES, The Joint Stock Company and A. Totte, London.
26,150. CLEARING DEPOSITS from the MOUTHS of HARBOURS, W. Critchlow, London.
26,151. WINDING FABRICS on CARD, B. J. B. Mills.—(*A. Dauvergne, France.*)
26,152. LIQUID METERS, C. D. Abel.—(*La Compagnie Generale des Compteurs [Société Anonyme], Belgium.*)
26,153. TELEPHONIC APPARATUS, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
26,154. HEATING, D. Tschernoff, London.
26,155. INCANDESCENT GAS BURNERS, W. Hooker, London.
26,156. TARGETS, R. Haddan.—(*C. Chevallier, M. Lallement, and E. Cadet, France.*)
26,157. EXTRACTION of RUBBER, J. de la Fresnaye, London.
25,158. SWITCH for CHANGING LIGHTS, W. L. Campbell, Brighton.
26,159. CHAIN WHEEL, W. and A. Robertson, Manchester.
26,160. CHAINS, J. Westaway, London.
26,161. COTTER PIN DRIVER for CRANKS, W. H. J. Grout, London.
26,162. BRAZELESS CYCLE FRAMES, J. J. Underwood, Birmingham.
26,163. SPRING MATTRESSES, H. de Stedingk, London.
26,164. RESISTANCE SWITCH, C. B. Callow and J. Eck, London.
26,165. TIME MEASURES, R. T. and J. G. Glover, London.
26,166. BRAKE APPARATUS for SHIPS, A. E. Sorby, London.
26,167. COLOURING MATTER, H. R. Vidal, London.
26,168. COLOURING MATTER, H. R. Vidal, London.
26,169. CONCENTRATING SULPHURIC ACID, J. L. Kessler, London.
26,170. LETTER-CARDS, R. Davis and B. Roussat, London.
26,171. PLUGGING MATERIAL for TEETH, A. Biber, London.
26,172. CASTORS for FURNITURE, W. P. Spooner, London.
26,173. PUZZLE, E. Eckenstein, London.
26,174. CIGARETTE-MAKING MACHINE, W. G. Pedersen, L. Adler, and P. N. Holst, London.

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26,175. ADVERTISING DEVICES, A. R. Boaz, London.
26,176. INJECTORS and WATER ELEVATORS, A. H. Smith, Nottingham.
26,177. COCKS and VALVES, A. H. Smith, Nottingham.
26,178. CORSETS, C. L. Reynolds, London.
26,179. RING JOINTS for FLANGES, J. E. Slack, Manchester.
26,180. BILLIARD DETACHABLE APPLIANCES, J. W. Dean, Stroke-on-Trent.
26,181. CYCLE SUPPORT, J. Attridge, Bournemouth East.
26,182. ASHPITS for FIREPLACES, C., F., and W. Riley, Burnley.
26,183. COUPLING LINK, G. F. Nicholson and F. Moss, Great Grimsby.
26,184. CYCLE BACK FORK END ADJUSTMENT, B. Gorton and T. S. Yardley, Coventry.
26,185. VEHICLE WHEELS and BEARINGS, R. B. Hellihwell, Liverpool.
26,186. STEAM-CONDENSING APPARATUS, J. I. Booker, Leeds.
26,187. SELF ACTING MULES RING FRAMES, J. Seville and R. Clegg, Manchester.
26,188. SPINNING MULES, J. D. White, Manchester.
26,189. AUTOMATIC STEAM INJECTOR PUMPS, E. A. Charters, Plymouth.
26,190. TOBACCO PIPE CLEANER, A. W. Sale, Northampton.
26,191. ELECTRIC SWITCHBOARDS, E. W. Cowan and A. Still, Bowden, Cheshire.
26,192. CYCLE STEERING LOCK, P. Spencer, Liverpool.
26,193. SECURING CYCLE HANDLE BARS, P. Spencer, Liverpool.
26,194. MOULDING SOCKET PIPES, &c., F. Herbert, Durham.
26,195. CINEMATOGRAPHIC APPARATUS, J. E. Thornton, Altrincham.
26,196. CINEMATOGRAPHIC PICTURES, J. E. Thornton, Altrincham.
26,197. LITHOGRAPHIC MACHINES, H. Erskine, Glasgow.
26,198. LOCKING DEVICES for NUTS, H. R. Walker, Liverpool.
26,199. SURFACE CONDENSERS, W. B. Thompson, Dundee.
26,200. PRESERVING EMBOSSED DESIGNS on PAPER, G. Bathgate, Glasgow.
26,201. BUNG for CASKS, N. F. Debroux, Glasgow.
26,202. PNEUMATIC TIRES, J. Brooker and J. Cruickshank, London.
26,203. CYCLE DRIVING GEAR, J. Brooker and J. Cruickshank, London.
26,204. ICE and SNOW VEHICLE, V. Seeser, United States.
26,205. SMOKE FLUES, J. I. Bruce, Low Gosforth, near Newcastle-on-Tyne.
26,206. VAPORISING OIL for OIL ENGINES, H Austin, Wolverhampton.
26,207. CURTAIN RINGS, L. J. Steele, London.
26,208. JOINTING PIPES, R. and W. Mark, Cumberland.
26,209. AUTOMATIC DUSTLESS COAL, H. R. Reynolds, Ontario, Canada.
26,210. ELECTRIC MOTORS, F. O'C. Prince, London.
26,211. WEAVING SHUTTLES, W. C. Priestley, Pudsey, Yorks.
26,212. BENDING METAL TUBES, G. Chisholm, jun., Glasgow.
26,213. BOAT, G. Davis, Aberystwyth.
26,214. ELECTRICAL FURNACE, E. B. Phillips and W. H. Bray, Leicester.
26,215. ENRICHING GASES by ACETYLENE, W. J. Rodwell, London.
26,216. ELASTIC MOULDINGS for FLOORS, W. Houben, London.
26,217. APPLIANCE for MODERATELY HEATING, K. W. Hodges, London.
26,218. BEARINGS for BOWL CENTRES, W. and J. Partington, London.
26,219. SPEECH-RECORDING APPARATUS, J. Y. Johnson.—(*The American Gramophone Company, United States.*)
26,220. CYCLE CRANKS, J. Turnbull, London.
26,221. INCANDESCENT GAS MANTLES, F. and M. L. Missire, London.
26,222. COMBINATION FURNITURE, L. Wolz, London.
26,223. WHEELS for VEHICLES, P. Samois, London.
26,224. AUTOMATIC RAILWAY SIGNALS, C. de M. da S. Lobo, London.
26,225. CANDLESTICKS, W. Langbridge, Doncaster.
26,226. STRAW HAT, L Delaunay and A. Garde, London.
26,227. PROPELLING BOATS and VESSELS, W. White, London.
26,228. CYCLES, S. B. Hill and F. W. Schroeder, London.
26,229. FASTENING GLOVES, E. C. Vaudrey, London.
26,230. POWER GENERATING MACHINE, C. Bondiek and F. Sievers, London.
26,231. BANDAGE for INJURED LIMBS, E. Kohlmetz, London.
26,232. HAIR COMB, R. Charlton, London.
26,233. BOOKBINDING, W. C. Leechman, London.
26,234. PAPER, W. C. Leechman, London.
26,235. REGULATING DEVICE for GAS BURNERS, W. Knopf, London.
26,236. VALVES for PNEUMATIC TIRES, E. F. Pickitt, Buffalo, New York.
26,237. GENERATING ACETYLENE GAS, D. J. van Praag and F. W. Harker, London.
26,238. VALVES, The Economical Gas Apparatus Construction Company, Limited, and A. I. Payne, London.
26,239. ELECTRIC MEASURING INSTRUMENTS, J. Wetter.—(*The Elektrizitäts Aktiengesellschaft vormals Schuckert and Co., Germany.*)
26,240. METALLIC PIPES, R. A. Lowe and H. Line, London.
26,241. VELOCIPEDES, G. P. Mills, London.
26,242. BALANCING WINDOW SASHES, G. Massey, London.
26,243. BOTTLE STOPPER and CAPSULE, J. S. Barr, London.
26,244. STEAM GENERATORS, J. Brotan, London.
26,245. MAP HOLDERS, C. M. Stuart, London.
26,246. PERCUSSION TABLE, R. F. and G. A Waller, London.
26,247. HEATING DEVICES, W. P. Thompson.—(*R. Tockermann, Germany.*)
26,248. STARTING SWITCHES, J. W. Gibbs, Liverpool.
26,249. RODS of EXPLOSIVE MATERIALS, H. Maxim, London.
26,250. AUTOMATICALLY DELIVERING LIQUIDS, A. E. Phare, London.
26,251. ELECTRICAL TRANSFORMERS, O. T. Blathy, London.
26,252. PREVENTING AIR RECEDING in TUBES, G. H. Buckeridge, London.
26,253. COKING, R. Brunck, London.
26,254. MANTLES for GAS LIGHTING, W. H. A. Sieverts, London.
26,255. LAND-CULTIVATING IMPLEMENTS, T. C. Darby, London.
26,256. TREATING PEAT, W. F. Browne, London.
26,257. REGULATING DIFFERENCE of POTENTIAL, L. de Coincy, London.
26,258. OPENER for TINNED GOODS, T. J. Turner and C. Hindle, London.
26,259. PRODUCTION of HYDROCYANIC ACID, J. Büeb, London.
26,260. NICKEL ALLOYS, J. Patrick, London.
26,261. PARAXANTHINE, J. Y. Johnson.—(*C. F. Boehringer and Soehne, Germany.*)
26,262. COLOURING MATTERS, J. Y. Johnson.—(*The Badische Anilin and Soda Fabrik, Germany.*)
26,263. PREVENTING EROSION in GUNS, H. Maxim, London.
26,264. ACTUATING AUTOMATIC MACHINES, C. Ramspeck, London.
26,265. INFUSING TEA, H. F. E. Harris, London.
26,266. CYCLES, C. W. Atkinson, London.
26,267. DAMPING ENVELOPES, C. von Kanitz, London.
26,268. TIRES, C. H. Guest, London.
26,269. COKE OVEN, H. Poetter, London.
26,270 EFFECTING SMOKELESS COMBUSTION, A. Koeppe, London.
26,271. COMBINATION BRACE and BITS, W. H. C. Harrison, London.
26,272. SHODDY MILLS, U. Kohlöffel, London.
26,273. AUTOMATIC GAS IGNITER, C. F. P. Standebach, London.
26,274. TEMPLET for DRILLING SLEEPERS, L. Gross, London.
26,275. JAR HOLDER, A. Saunders, London.

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26,276. TROUSER BRACES, H. Withers-Lancashire, Stockbridge, Hants.
26,277. SLIDE VALVE RELEASER, P. Buckley, O. Holmes, and H. Hemingway, Leeds.
26,278. POTATO CLEANER, J. H. Johnson. Carlisle.
26,279. PIPE JOINT and COUPLING, D. Anderson, London.
26,280. BOTTLE, C. E. Cummins, Bishop Auckland.
26,281. CALCULATING PHOTOGRAPHIC EXPOSURES, A. Watkins, Hereford.
26,282. CHARRING FURNACE, G. I. Cree, Dublin.
26,283. SECURING TIRES on WHEEL RIMS, A. T. Collier, London.
26,284 DISINFECTING APPARATUS, J. Lee, New Ferry, Cheshire.
26,285. SWITCHES, S. H. and H. W. Heywood, Manchester.
26,286. REVOLVING RIDDLES, D. Gillies, Bonnybridge, Stirlingshire.
26,287. MAUSSER RIFLE, R. M. Ramirez, London.
26,288. MECHANICAL STOKERS for FURNACES, J. F. Pool, London.
26,289. AUTOMATIC LOOM "KNOCK-OFF" MECHANISM, J. W. Hill and E. Bardsley, Manchester.
26,290. STOP VALVES, J. Hodkinson, Nottingham.
26,291. CUT-OUT LETTERS and FIGURES, J. Y. Johnston, London.
26,292. DABBING MOTIONS for COMBING MACHINES, J. E. Stephenson, Bradford.
26,293. BRONZING MACHINE, F. G. Job, E. Marsden, and J. A. Hunter, Bradford.
26,294. ATTACHING HARNESS WEIGHTS to WIRE MAILS, J. A. Greenwood. Bradford.
26,295. STEERING LOCKS for VELOCIPEDES, B Yates, Coventry.
26,296. MINERS' TOKENS M. McDicken, Glasgow.
26,297. FANLIGHT-CLOSING APPARATUS, G. F. Newman, Birmingham.
26,298. EYES for HOSE, F. Parkes, Birmingham.
26,299. FURNITURE CASTORS, J. Cooper and F. G. Benely, Birmingham.
26,300. LEAD TRAY-MAKING MACHINES, G. Thompson, Edinburgh.
26,301. FRONTS, T. C. Fawcett, Halifax.
26,302. APPARATUS for CORKING BOTTLES, G. Bowen, Keighley.
26,303. LETTER FILES, P. Spencer, Birmingham.
26,304. TIRES, W. T. Shaw, I. W. Boothroyd, and A. Sydenham, London.
26,305. MARINE PROPELLERS, G. Gay, London.
26 306. ATTACHMENTS to BUOY LAMPS, W. T. Parrott, Hull
26,307. PACKING CASES, H. H. Macaulay, Glasgow.
26,308. MEANS for PROPELLING CYCLES, W. Goodlet, Glasgow.
26,309. GAS MOTOR IGNITION TUBE, A. E. Heckford, Birmingham.
26,310. DISTRIBUTION BOARDS for ELECTRIC WIRING, G. A. Clark, W. McAulay, and J. A. McLaren, Glasgow.
26,311. PETROLEUM ENGINES, R S. Blackwood.—(*G. H. Rogers, South African Republic.*)
26,312. COFFINS, J. Murray and D. McGregor, London.
26,313. LITHOGRAPHIC TRANSFER PAPER, C. H. Veale, London.
26,314. SASH LOCKS, A. J. Boult.—(*T. A. Stevens, United States.*)
26,315. BALL BEARINGS for ELECTRIC MOTORS, J. M. Murphy, London
26,316. SHIPS' VENTILATORS, R. Thompson, S. J. Glover, and J. Porter, Newcastle-on-Tyne.
26,317. COVERS of JUGS, M. Stern.—(*C. Kayser, Germany.*)
26,318. SLIDING BOLTS for DOORS, J. May, London.
26,319. WATER TAP and FILTER COMBINED, H. Barraud, London.
26,320. FOLDING MACHINES, F. H. Wendt, London.
26,321. CYCLING SKIRTS, E. and G. Slatter and G. W. Richardson, London.
26,322. REGULATING the DIFFERENCE of POTENTIAL, L. de Coincy, London.
26,323. FRIGORIFIC ELECTRO SPRAY, E. S. D'Odiardi, East Croydon.
26,324. VOLATILISERS of METALS, E. S. D'Odiardi, East Croydon.
26,325. ELECTRODES of DEEP PENETRATION, E. S. D'Odiardi, East Croydon.
26,326. ABSCESS BELLS and ELECTROLYSERS, E. S. D'Odiardi, East Croydon.
26,327. ELECTRO INHALERS and NASCENT OZONE PRODUCERS, E. S. D'Odiardi, East Croydon.
26,328. ELECTRO VAPOURISERS and OZONISERS, E. S. D'Odiardi, East Croydon.
26,329. BAIL for PAILS, S. R. and H. R. Docking, London.
26,330. VICES, H. B. Bryan, London.
26,331. FOLDING RACKS, H. H. B. Rust and J. Dupiérris, London.
26,332. MATCH, W. P. Jones and H. M. Bates, London.
26,333. NEW GAME, H. Theobald, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

610,946. WATER-COOLING DEVICE, *W. F. Nieding, Cincinnati, Ohio.—Filed December 23rd*, 1897.

Claim.—In a device for cooling water, the combination of a number of pans having perforated bottoms, a

610,946.

water pipe discharging into the uppermost pan, a central upright shaft on which they are supported, one below the other with a space between them and means to rotate said shaft.

611,092. MEANS FOR SECURING HEADS OF AXES, HAMMERS, &C., TO THEIR HANDLES, *F. Baker, Caulfield, Victoria.—Filed February 7th*, 1898.

Claim.—The combination with a tool provided with an eye having one edge constructed with an inclined plane, of the handle B inserted through the eye of the tool and constructed at the edge facing the aforesaid inclined plane with a longitudinal concaved edge E,

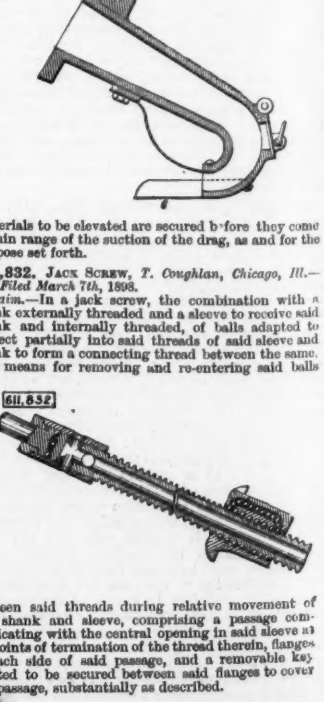
611,092.

and the locking piece C inserted through the eye of the tool and formed at its opposite edges respectively, with the convex face F and taper H, the convex face of the locking piece fitting the concaved edge of the handle, and the taper of said locking piece fitting the inclined plane of the eye in the tool, all substantially as described and shown.

611,148. APPARATUS FOR ELECTRICALLY COATING WIRE, *W. S. Rawson, London, England.—Filed December 24th*, 1897.

Claim.—An apparatus for electrolytically coating wire, consisting of a tank for containing the electrolyte liquid, an upright insulated frame arranged to be partly immersed in said liquid, a plurality of pulleys

611,148.

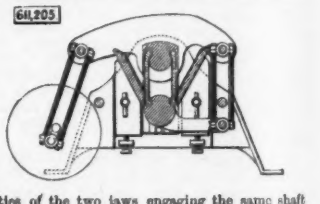


circularly arranged on the insulated frame, an anode outside the circular pulleys, an anode located in the space within the circularly-arranged pulleys, and a cathode connection arranged to contact with the wire coiled about the pulleys, substantially as described.

611,205. ROCK BREAKER AND CRUSHER, *J. R. Moffit, Denver, Colo.—Filed June 22nd*, 1897.

Claim.—In an ore pulveriser, the combination of two rock shafts, one located above the other, two pulverising plates or jaws having their extremities movably connected with said shafts on opposite sides, the ex-

611,205.



tremities of the two jaws engaging the same shaft lying in a horizontal plane passed through the shaft to one side of its centre co-operating pulverising plates located in suitable proximity to said jaws, and suitable means for operating the rock shafts.

611,614. DREDGING DRAG, *J. Edwards, New York, N.Y.—Filed March 21st*, 1898.

Claim.—On a suction dredging drag the elongated under-thrust shovel 6 having its rear end attached to the lower lip of the mouth of the drag, whereby the

611,614.

materials to be elevated are secured before they come within range of the suction of the drag, as and for the purpose set forth.

611,832. JACK SCREW, *T. Coughlan, Chicago, Ill.—Filed March 7th*, 1898.

Claim.—In a jack screw, the combination with a shank externally threaded and a sleeve to receive said shank and internally threaded, of balls adapted to project partially into said threads of said sleeve and shank to form a connecting thread between the same, and means for removing and re-entering said balls

611,832.

between said threads during relative movement of said shank and sleeve, comprising a passage communicating with the central opening in said sleeve at the points of termination of the thread therein, flanges on each side of said passage, and a removable key adapted to be secured between said flanges to cover said passage, substantially as described.

THE WORKS OF THE ILLINOIS STEEL COMPANY, U.S.A.

(*Concluded from page 610.*)

WE continue from our last issue the description of the South Chicago Works of the Illinois Steel Company. At the rail mill the ingots are placed upright in soaking pits, heated by petroleum, the air for combustion passing through regenerators which have been heated by the waste gases leaving the pits. These pits are rectangular in form, each holding twelve ingots, and are placed in two rows, one on each side of a line of rails leading to the ingot run of the blooming mill. On this track runs a tilting transfer car, operated by cable. The ingots are hoisted out of the pits and loaded on the car by cranes. Four of the pits are served by two overhead electric travelling cranes of 25 tons capacity, each having a traversing trolley, which carries the hoisting gear. The cranes have a span of 78ft., and the speed is 300ft. per minute for travelling, and 100ft. per minute for hoisting. The other pits are served by four Wellman jib cranes, similar to those at the Bessemer mill, but hoisting only one ingot at a time. These, however, are to be removed, leaving the travelling cranes to serve all the pits.

The blooming mill is of the three-high type, with rolls 40in. diameter. It is driven by a Porter-Allen steam engine of 1600-horse power, having a cylinder 44in. by 66in. Here the ingot is reduced to an 8in. bloom about 24ft. long, which is then cropped and cut into three blooms by the bloom shears. The crop ends drop below the floor level into a conveyor, and this loads them into scrap cars, by which they are taken back to the Bessemer works while still hot. Each bloom makes a 30ft. rail.

Between the shears and the table of the first roughing rolls is a tilting table, which drops the blooms into a conveyor running to a re-heating furnace. This serves as a reservoir, taking the blooms when the blooming mill is running too fast for the rest of the machinery, and delivering them when the mill is running too slow.

The first roughing and finishing rolls are driven by an engine of 2800-horse power, having cylinders 54in. and 66in. and running at 72 revolutions per minute. The second roughing and dummy rolls are driven by an engine of 1700-horse power, with cylinders 44in. by 66in. These engines are similar to that of the blooming mill, and all three have 25ft. fly-wheels of 55 tons weight, and run at 80 to 90 revolutions per minute. They are to be converted to a compound-condensing type. A plan contemplated in order to ensure increased economy in fuel consumption is to establish a central condensing plant at the rolling mills.

The building was originally designed for a 26in. two-high mill, and therefore the present 27in. three-high mill, designed in 1889 by Mr. Forsyth, is in two parts, placed tandem with the blooming mill. There are twenty-two passes from the ingot to the finished rail, nine in the blooming rolls, five in the first roughing rolls, four in the second roughing rolls and dummy rolls, and four in the finishing rolls.

The piece is about 65ft. to 95ft. long when it leaves the finishing rolls, and is cut to length by saws running at 1500 revolutions per minute, being driven by belting from a Westinghouse high-speed engine. As the rail leaves the runway from the saws it passes through a cambering machine, which gives it a camber or sweep of 8in. to 15in., according to the form of the rail section, the head of the rail being convex. A well-balanced section will require less camber than one having a heavy head and light flange. The rails then go to the hot beds to cool, and in cooling the camber is taken out and the rail becomes level.

The cold rails are loaded by machine on to a car hauled by an engine on a narrow-gauge track, running the full length of the finishing building. At the straightening bed, in this building, the car is unloaded by admitting steam from the engine into two cylinders under the car, the piston-rods tilting the car until the rails slide off. The building is 150ft. by 360ft., and is equipped with straightening presses and drills.

The rails are first inspected on all sides for flaws, gag marks, and straightness. They are then drilled for the fish bolts, and again inspected. They are then loaded upon railway cars, and finally given a check inspection on the cars before the shipping clerk is instructed to invoice out the shipment. The clerk's record shows the number of the car, number of rails, brand of rails and length, section and drilling, &c. All rails inspected by night are placed on skids outside the building, and there re-inspected next day.

Two rail ends for each heat, 3½ft. to 4½ft. long, according to the weight and section and the specified spacing of the supports, are laid aside to cool, and stamped with the heat number the same as the rail. These represent the steel taken from the upper part of the cropped ingot, and are subjected to the drop test. The pieces of rails less than 80 lb. per yard are placed on supports 3ft. centre to centre, and those weighing more than 80 lb. per yard on supports 4ft. centre to centre. A 2000 lb. hammer is used, falling 14ft. for rails up to 60 lb. per yard—3ft. span—or 20ft. for 100 lb. rails—4ft. span. If one piece fails and the other stands, while the chemical analysis is satisfactory, the rails of that heat are passed.

Every hour a 12in. piece of rail is cut off, and when cool is carefully measured by Brown and Sharpe's steel calliper gauges, to ensure accuracy in the section. Single rails are also weighed every hour, to check the weight.

The inspection is carried on by a special department, independent of the mill. Men who have been given a special training attend to the inspection of all steel products, such as rails, fish plates, spikes, bolts, rivets, car axles, plates, rolled joists, and other shapes.

The rail mill has a capacity of about 500,000 tons per year. The rails weigh from 30 lb. to 100 lb. per yard, and are from 30ft. to 60ft. in length.

A special feature of the mill is the system by which billets of various sizes can be rolled as required. Extra passes are provided in every set of the first and second roughing rolls, and movable tumblers are so placed that a bloom may be directed either into the rail passes or into the billet passes. Beyond the tables of these rolls is a runway carrying the billets to a duplex horizontal hydraulic shearing machine, by which they are cut to any size ordered. The billets are then carried by a surface conveyor to the outside of the building and dropped upon a transverse conveyor which raises them to an elevated conveyor. The latter carries them across the billet storage yard and drops them on any desired stock pile by means of a switch. The horizontal conveyors have side chains composed of links riveted upon a pin carrying a roller. On these rollers the billet moves at double the speed of the conveyor.

By this arrangement any portion of the product of the mill can at any time be made into billets, all that is necessary being to signal the leverman at the roughing rolls whether to send the bloom into a rail pass or a billet pass. The mill can therefore supply billets of any degree of carbon and in any quantity, without interfering with the rate of production by loss of time in changing the rolls. The facilities are such that 900 tons of billets, 3⅜in. square, can be rolled in twelve hours. It is believed that no other mill in the United States has this arrangement.

The open-hearth steel department was designed by Mr. S. T. Wellman, the inventor of the rolling furnace, and was put in operation in 1895. The building is of brick and steel construction, 651ft. long, and 100ft. wide, containing ten furnaces in a row along one side, thus leaving the other half available for the seven casting pits. There are six Wellman rolling furnaces, four being of 60 tons, and two of 25 tons capacity. Also four Wellman stationary Siemens regenerative furnaces of 25 to 30 tons capacity. The capacity of output of the ten furnaces is 175,000 tons of ingots and castings per year. As a new 50-ton furnace has recently been put in, it has been necessary to increase the space for casting, and for this purpose a steel foundry or casting house, 30ft. by 150ft., has been erected.

The rolling furnaces are horizontal cylinders of steel plate, revolved on trunnions by means of two vertical hydraulic cylinders on the casting side of each furnace. These were illustrated in our last issue, page 620, and were in error entitled mixers. These mixers, however, closely resemble the furnaces. Fig. 4 is a view of the side of one of the furnaces, showing the spout at the tapping hole, and the two operating cylinders. Fig. 5 is a view of the charging side of the same furnace.

One of the advantages of the rolling furnaces is that during the working of the furnace the tapping hole is removed out of the way of the metal, and therefore does not need to have the heavy sealing of refractory material which the stationary furnaces require, and the breaking open of which requires considerable labour, and often causes trouble and delay at a critical moment. They also have advantages in regard to facilities in repairing the lining after a heat, or temporarily even during a heat. Oil fuel is used, being cheaper and more convenient than coal gas from the producers; but the latter can be used whenever necessary, as there is a gas-producing plant at the works. In two of the furnaces, designed by Mr. C. E. Stafford, manager of this department, as an improvement upon the Wellman furnaces, the gas and air ports are in the stationary ends of the furnace. This decreases the weight of the moving parts, simplifies the construction, and enables new ports to be set without seriously delaying the operation of the furnace. When the furnace is in its normal position, the ports coincide with the openings in its ends. As it is revolved for pouring, the holes are partly covered, and when in position for pouring the gas and air are entirely shut off.

Behind the furnaces is the charging floor, 12ft. above the main floor—Fig. 5. Below this are the Siemens regenerators, and the gas and air ducts and valves. The stock for charging the furnaces is loaded in steel boxes, placed on narrow-gauge cars, which are then run up an incline to the charging floor, and along a track at the side of the furnaces. Three Wellman electric charging machines, running to and fro along the charging floor, serve the ten furnaces. The machine has a long bar projecting in front, with a head fitting into socket on the back of the charging boxes. The machine is run along behind one of the cars; its bar is thrust out, and turned to engage with the socket of a box. It then runs back to the desired charging door, thrusts the box into the furnace, turns it over at any desired point, withdraws it, and then replaces it on the car. All doors and gas valves of the furnaces and regenerators are operated by pneumatic cylinders, controlled by boys, who work the various cocks on the charging floor.

Molten metal from the blast furnaces may be used instead of pig iron and steel scrap, and this tends to reduce the time per heat, the fuel consumption, and the loss of charge by oxidation. A battery of gas producers supply bituminous coal gas as fuel for the furnaces if desired, instead of petroleum. For casting, the melted steel is run into ladles of 30 tons to 75 tons capacity, suspended from travelling cranes which carry them to a pit full of moulds. A casting pit of large diameter, 30ft. deep, and lined with steel, enables large ingots to be cast, weighing as much as 150 tons each.

A 20-ton electric travelling crane of 50ft. span extends over the charging floor and the furnaces, and runs the entire length of the building. In front of the furnaces are five electric travelling cranes, also running the length of the building. They include two cranes of 75 tons capacity, one of 40 tons and two of 30 tons. These cranes carry the ladles for casting, the ladles having capacities of 30 tons and 50 tons. The pouring hole is in the bottom of the ladle, the plug or valve being operated by a lever. For bottom pouring the ingots, a series of moulds is placed around a central casting gate, with runners extending to the moulds. The ingots for plate making are usually slab shaped, 2ft. to 5ft. long, 18in. to 30in. wide, and 8in. to 24in. thick. For making special forgings, ingots of much larger size are cast.

The plate mill is near the open-hearth plant, and is operated in connection with it, the two being connected by lines of broad-gauge and narrow-gauge tracks. This mill is equipped with a pre-heating furnace and four re-heating furnaces for the ingots, which are brought in on cars or trucks built of iron.

The pre-heating furnace is on the line of rails on which these cars are run, and is so built that the cars can run through it, the track being so inclined at each end that the overhanging sides of the car form a water seal, and prevent the access of cold air. The tops of the cars are covered with sand. The ingots are heated by being run slowly on the cars through the pre-heating furnace, thus preventing any trouble from putting a chilled ingot into a hot furnace. In the re-heating furnaces, the ingots are raised to a temperature suitable for rolling. Two Wellman electric-hydraulic charging cars carry the ingots from the car to the re-heating furnaces, and from these furnaces to the roller tables of the rolling mill.

There are two three-high plate mills, one having rolls 7½ft. and the other 11ft. long; the latter is said to be the largest plate mill in the United States. The 7½ft. mill has top and bottom rolls 34in. diameter, and the middle roll 22in. diameter. The 11ft. mill has its rolls 36in. and 22in. diameter; the top and bottom rolls are driven by the engine by means of gearing, while the middle or intermediate roll is moved up or down in its bearings by the plungers of hydraulic cylinders. For the bottom pass this roll is raised until it bears against the top roll, which supports its whole length; for the top pass, it is lowered until it rests upon the bottom roll. This arrangement enables a middle roll of comparatively small diameter to be used without fear of bending.

The bottom roll is not adjustable as to position, but the top roll has a vertical movement in the frames or housings, and is counterbalanced so as to bear against the lower ends of heavy vertical screws in the tops of the housings. A man at the screws turns them as desired, thus regulating the width of pass in accordance with the directions from the head roller, who frequently measures the thickness of the plates by means of spring callipers, measuring to the thousandth part of an inch. About twenty-five to thirty-five passes are required, according to the size of the ingot and the thickness of the plate.

The rolls run continuously in one direction, without any reversing. Both roll trains are driven by a Porter-Allen engine of 3000-horse power, with cylinders 54in. by 66in. The tables are driven by reversing engines having cylinders 8in. by 10in. These tables are pivoted at the outer ends, and are raised by hydraulic power to deliver the plate to the upper or lower pass as required.

The plates are finished at a dull red heat, and are carried by another table to the hot-bed to cool. Cold plates that are buckled are then passed through a set of cold straightening rolls. From the hot-bed or the plate storage stacks the plates are carried to the marking beds, where they are marked with chalk to the required dimensions, and are then carried to the shear tables by electro-magnetic hoists. One of the shears is a rotary machine, in which the blades are two steel discs mounted on stationary shafts. The plate being clamped in the centre is revolved, and is thus cut in circular form, as for boiler heads, &c. The largest shearing machine has blades 11ft. long, capable of cutting a plate 2in. thick and 11ft. long. Other shears have blades 8ft. 4in. and 9ft. 2in. long.

Around the shears the plates rest on a series of castors fitted to the tops of vertical iron rods or bars, 2ft. apart, the castors being in a plane with the level of the tables of the shearing machines. As the wheels of the castors revolve, and each castor also revolves around its post, the heaviest plates can easily be pushed from one machine to the other, and to the weighing scales.*

Many of the machines in the mill and shear-room are operated by electricity, and magnetic hoists are used for handling the plates. There are two electric overhead travelling cranes to carry the plates to the shears and to the stock racks. One of these is fitted with the ordinary hooks on chain slings, which require two men to attach them to the plate to be moved. The other is fitted with a row of seven electro-magnets suspended from the bridge of the crane, and extending the full width of the hot-bed. Any plate up to 60ft. in length can be lifted by placing the magnets over it and turning on the current. The crane then carries the plate to any desired point, where it is released by shutting off the current to the magnets. One man controls all the operations of lighting and conveying. The magnets have a current of 240 volts and 4 ampères, and each can lift five tons of steel. The two 5-ton electric travelling cranes which serve the shears and the shipping or loading track are each fitted with a single 5-ton electro-magnet. These are specially convenient in loading the railway trucks or cars, as it is often difficult to disengage the hooks from under plates when deposited in the car.

The electric power plant is operated by three compound condensing engines. Two of these, built by the Lake Erie Works, are of 250-horse power each; the third, built by McIntosh and Seymour, is of 500-horse power.

The plate mill has an annual capacity of 84,000 tons of finished plates, and in ordinary service it can turn out plates from $\frac{3}{16}$in. to 1½in. in thickness, 10ft. 6in. wide, and 60ft. long. Some very large boiler plates, 1½in. thick, have been made for a lake steamer, the boiler carrying 200 lb. working pressure. There have also been rolled some huge plates for locomotive fire-boxes, each plate making the top and both sides of a fire-box shell, thus avoiding longitudinal seams.

The latest addition to these extensive works is a combination slabbing and blooming mill, contained in a building 350ft. by 70ft. It is intended primarily to pre-

* A similar device is in use at the new Dowlais Steel Works, Cardiff.

pare slabs for the plate mill, reducing ingots to half their original size, and thus increasing the capacity of the plate mill about 50 per cent. It also enables large ingots to be used, and a better grade of product with less waste can be made by slabbing a large ingot to a size suitable for rolling, than by rolling direct from a smaller ingot. The slabs from the upper parts of the ingots will go to make second-class plates.

The slabbing mill has one set of 32in. horizontal rolls, 7ft. long, and another set of 20in. vertical rolls, all sides of the ingot being thus rolled at one pass. A special and novel feature of the mill is that the vertical rolls can be drawn aside to clear the horizontal rolls, which can then be operated as a blooming mill. The middle part of the roll is cylindrical, taking a slab up to 40in. in width, and outside of this part are passes, which will take an ordinary ingot. The position of the rolls is regulated by screws and hydraulic pressure, and the rolls can be spread to give any width of opening up to 36in.

Two sets of reversing engines drive the mill. The horizontal rolls are driven by a pair of engines with cylinders 26in. by 30in. The vertical rolls are driven by a pair of engines with cylinders 46in. by 60in., geared 5 to 7. The equipment of this mill includes six soaking pits, served by electric cranes operating tongs, which can be revolved, opened, and closed by power.

The following description of the methods of marking and inspecting plates is taken from a paper written by Mr. T. L. Condron:—

Each separate cast from an open-hearth furnace or a Bessemer converter is given a serial number, by which the metal therefrom is known. The ingots, after removal from the moulds, are each stamped with their proper heat number. When an order for plates is received at the plate mill, it is necessary to select such ingots as will be suitable to fill the specifications for quality and requirements as to sizes of plates. Certain melts are selected as being suitable by reason of their chemical composition, records of which have been sent to the plate mill. Ingots of proper size from such melts are ordered into the mill, and placed in the heating furnaces in a regular routine.

The head roller is furnished with a card for each ingot, giving details of its size, weight, and composition, and the size of plate to be rolled therefrom. He rolls according to these cards, and notes any accident that may result in the loss of a plate or a change in the order in which ingots are rolled. The hot-bed man, or "layer-out," marks the plates in the order in which they reach the hot-bed, so as to identify them from the cards he receives in turn from the head roller. As soon as the plates are sufficiently cool, they are marked with the heat number, order number, for whom intended, and the sizes to which they are to be sheared. The melt numbers are stamped into the steel, and all other marks are painted on with white lead. Such plates as are to be cut for tests are so marked, and four or eight test pieces, 18in. long by 2in. to 3in. wide, are marked to be sheared off. Match marks are made on all test pieces, so that after shearing they can be identified with the plate from which they were cut, if necessary.

After the test pieces are sheared off they are taken to the milling machine, where they are milled into proper shape. Each test piece bears the marks of the plate from which it was cut, showing the heat number, the order number, and from what part of the plate it was taken. Both tension and bending tests are made upon these test pieces, and in special cases other tests, as may be required by the specifications. On orders subject to inspection by a representative of the purchaser, these tests are made in the presence of such inspector, who keeps a record of the same. After the necessary or required tests have been made, the inspector makes a list of accepted melts, noting any melt which may have failed under test. With this list in hand, he is able to identify every plate on his order, and will know if it is from a melt that has passed satisfactory tests.

In the space between the weighing scales and the shipping track the final inspection is made. For the purpose of exposing the plates for careful surface inspection, each plate is suspended from one of the magnets, enabling the inspector to examine the under side. In case he discovers a defect, the plate is passed over the inspection pit, where it rests upon goose-neck rollers or castors. The pit is supplied with a number of incandescent electric lamps, which enable a thorough examination to be made to determine if the defect is an injurious one or not. If the plate thus examined is found acceptable, it is stamped by the inspector and loaded on a car for shipment. If an injurious surface defect is discovered, the plate is rejected, and is removed by the crane to the back of the shear room. Such a plate may be cut into a smaller plate, or it may have to be cut up into scrap and returned to the open-hearth department to be remelted.

The Bessemer converting works, open-hearth steel works, rail mill and plate mill, have each a producer plant for making coal gas for fuel. Oil fuel is used with success for heating the steel furnaces, soaking pits, &c.

Machinery is built and repaired at the works, the equipment including a machine shop 300ft. by 150ft., an ironfoundry, steel foundry, blacksmith shop, carpenter shop, and pattern shop. All the ingot moulds are made in the ironfoundry, and give good service.

The various engines and pumps used have 350 steam cylinders, and aggregate 25,000-horse power. As has been noted before, several of the engines are to be converted into compound condensing engines, and otherwise improved in the interests of fuel economy. These engines and pumps are supplied with steam by 200 horizontal tubular stationary boilers. These are arranged in batteries of two, with an iron smokestack or chimney to each battery. Most of the boilers are 6ft. diameter and 20ft. long, fitted with fifty tubes, 4½in. diameter. The main boilers at the various boiler houses are equipped for burning either coal or oil.

A pumping station is situated at the west end of the North Dock, and contains three compound condensing Porter-Allen high-speed engines, each coupled directly to a centrifugal pump of 1,000,000 gallons capacity per hour. Steam is supplied by four boilers of the type above described. The water is lifted 10ft. and forced 8ft., being delivered through a 48in. pipe into a 40ft. tank. The engines and pumps were built by the Southwark Foundry and Machine Company, and there is provision made for putting in another engine and pump. From the tank the water is pumped by Worthington compound pumping engines to blast furnaces Nos. 5 to 8, to the plate mill, the open-hearth steel plant, and the shops of the Chicago, Lake Shore, and Eastern Railway. The blast furnaces Nos. 1 to 4, the Bessemer plant, and the rail mill have their own pumping engines, taking water from the South Dock. Most of these are Worthington compound condensing duplex pumping engines.

The plant includes an extensive central laboratory, where analyses are made of the ore, coke, limestone, oil, and other raw materials, as well as of the pig iron, spiegeleisen, rails, billets, plates, and other steel products. Special attention is given to the study of the microstructure and crystallography of steel and iron in the various stages of manufacture; and, in fact, this matter is probably more closely studied here than at any other steel works in the United States, and more than is usually done at European works. These investigations enable the chemical composition to be determined independently of the chemist, and also enable the heat treatment and comparative rolling temperature to be determined. From this information the re-heating treatment can be regulated to suit the special conditions. Much original work has been done in this line, and was begun by Mr. A. Sauveur, who has contributed valuable memoirs on the work and its results to the American Institute of Mining Engineers.

Special chemical laboratories are operated at the Bessemer plant and open-hearth plant, as already described. These are rendered necessary from the fact that certain analyses must be made very promptly, in order that the processes may be regulated by the results. Near the plate mill is a well-equipped physical laboratory, where all steel is tested before shipment. Fig. 6 is a view of the central laboratory and main office buildings, with the open-hearth department in the rear.

An interesting feature of the works is the hospital, a two-storey and basement structure of brick and stone, 116ft. by 28ft., built in 1896. In the basement are the housekeeping department and hot-water heating plant, together with a special equipment for taking large photographs by the Röntgen ray system. This latter equipment enables the progress of healing of broken bones, &c., to be closely followed without disturbing the patient or removing the bandages. There are four private wards and two large wards containing ten beds each; also waiting rooms, dressing rooms, laboratory, an operating room, doctors' quarters, and a solarium. An electric elevator is provided, large enough to carry patients lying on stretchers. The hospital service is given free to the employés.

Mr. E. A. S. Clarke is the general superintendent of the South Works, which employ about 3500 men and a large staff of engineers, inspectors, chemists, department officers, and bookkeepers.

HARBOURS AND WATERWAYS.

Harbour and Dock Bills.—The Bills relating to harbours, docks, and piers, for which notices have been given for the coming session of Parliament, are fewer in number and of less importance than those which came before Parliament last year, when twenty-one plans were deposited, against fifteen this year and an average for the last ten years of 14·5.

Contrary to general anticipation, next session will not be enlivened by a revival of the fight between the great dock authorities in Wales. The Windsor Dock scheme, which occupied a very considerable time in Committee during the past two sessions, is not to be revived. It is stated that the Taff Vale Company, instead of promoting this new dock, are going to content themselves with an enlargement of Penarth Dock, so as to increase its water space and loading and discharging capacity. This can be done without further parliamentary powers. A prominent argument of the opposition to the Windsor Dock Bill was that Penarth Dock had not yet attained its maximum capacity, or exhausted its available resources. The change of policy, it is further rumoured, was brought about just previous to the time for giving the usual notices, at a meeting of representatives of the three great Cardiff interests, the Cardiff, Taff Vale, and Rhymney companies, at which some mutual understanding was arrived at as to the future course to be pursued.

The Clyde Trustees having successfully opposed both the Kilpatrick and Renfrew dock schemes, which were brought forward in the two past sessions, have given notice of their intention to apply in the coming session for powers to construct two new docks in the lower reaches of the river—one to be situated at Clydebank, or Yoker, nearly opposite where the river Cart joins the Clyde, and to have an area of 19 acres, with a quayage of 1800 lineal yards, and to comprise a large outer or canting basin. The other dock, at Shieldhall, lower down the river on the Renfrew side, and to enclose 45 acres of water, and to comprise a large outer basin, nearly rectangular in shape, 900ft. long by 800ft. wide, with a north basin, 750ft. wide, extending eastwards 850 yards, and a south basin of the same width, the total quayage to be 4000 lineal yards. The estimated cost of the complete scheme is £1,750,000.

Negotiations have for some time past been going on between the Clyde Trustees and those of the river Cart with the intention that the Clyde Trust shall take over the Cart and improve its navigable facilities, but for the present these negotiations have fallen through. A report prepared by Mr. Deas, the Clyde engineer, shows that the present navigable depth of the Cart is only from 6ft. to 10ft. over a width varying from 95ft. to 150ft. To make the river and harbour suitable for such traffic as might be expected to arise in connection with Paisley and the surrounding districts, and the prospective shipbuilding yards, Mr. Deas considers that it would be necessary to straighten the present channel and to deepen it to 15ft. at low water at the lower end and 10ft. above; the sharpest curve, which now has a radius of only 450ft., to be increased to 2000ft., and the narrowest parts to be widened to 160ft. at the junction with the Clyde, diminishing to 80ft., the estimated cost of the works is £190,000, exclusive of land.

The North-Eastern Railway Company having abandoned the intention of making a deep-water dock at the Old Docks at Hull, in accordance with the scheme which was so strongly opposed in the Session before the last and finally withdrawn, and then again brought forward last session, but withdrawn before it came into Committee, has now, in conjunction with the Hull and Barnsley Railway Company, deposited plans for a new joint deep-water dock to be constructed below the Alexandra Dock, belonging to the latter company. The new dock is to measure 1050 yards in length by 330 yards in width. A large portion of the foreshore of the Humber is to be enclosed by a river wall nearly a mile and a-half in length, running in an easterly direction from the extremity of the Alexandra Dock extension. The entrance dock is to be placed at an angle to the dock pointing up stream. The estimated cost of the undertaking is a million and a-half, and when constructed it is stated that this will be the deepest dock in the kingdom and that vessels of any size will be able to enter at any state of the tide.

The Aire and Calder Navigation Company intends to ask for power in the coming session to authorise the widening of the Goole and Knottingley Canal, and to construct a lock from the canal to the Dutch River, so as to obtain independent access to the Humber for the traffic expected to come from the Sheffield and South Yorkshire Navigation when the new junction canal is completed, so as to avoid the passage of the barges going to and from Hull through the docks at Goole. It is seeking also for powers to control the navigation over this river, which now is under the jurisdiction of the Hatfield Chase Commissioners, who, by an arrangement made in 1873, agreed to transfer their rights on payment of an indemnity to be agreed upon. Powers are also to be sought to abandon part of the works authorised by the Sheffield Canal Act, and to vary those obtained for the Junction Canal, with respect to the crossings over the rivers Went and Don. The works in the junction canal, which when completed will put the Sheffield Canal in connection with Goole Docks, and provide a shorter and better route to Hull than by the Trent to Keadley. A sad gloom has recently been cast over the proceedings, owing to the sudden death by the falling of some machinery, of the resident engineer, Mr. Wigan, who has had charge of the works, and of one of his staff.

The Bridgwater Corporation have deposited plans and a Bill for the improvement of the river Parrett. By this scheme it is intended to straighten the present tidal channel by two new cuts, shortening the distance about a mile, and doing away with eight sharp curves which now form a great obstruction to the navigation, forming a quay and landing-stage at the town, and connecting the same with the Great Western Railway, the estimated cost of the work being £105,000. There appears, however, to be considerable opposition to the scheme, the makers of Bath bricks, which is a monopoly confined to this town, fearing that the improvement of the river will necessarily interfere with their trade. The material from which these bricks are made is obtained from the warp deposited in places provided for the purpose on the banks of the river, and it is apprehended that, by improving the flow of the tide, and doing away with the present tortuous condition of the channel, these deposits will be interfered with. The scheme received the necessary majority at the meetings of the Town Council, but was opposed at the statutory meeting of the ratepayers by a majority, and a poll of the town has yet to be taken.

A scheme brought forward by the Somerset Drainage Commissioners for improving this river above Bridgwater, with a view to prevent the flooding of the land—which now is of frequent occurrence—at a cost of £40,000, is being seriously opposed by the owners and occupiers of the land, and does not appear likely to be carried.

The Hastings Corporation have been asked by the Harbour Commissioners to obtain parliamentary sanction to a guarantee of £3000 a year in order that they may be able to raise a further sum of £100,000 to finish the works of the new harbour. In face of the unfavourable report given by Sir Douglas Fox, who was called in by the Harbour Commissioners to examine the work so far completed, the Corporation do not seem very anxious to proceed in the matter, and have determined to call in an independent engineer to advise them.

Welsh ports.—The new dock at Barry, which has been in course of construction for some time, and which has been fully described in THE ENGINEER, has been opened for traffic without any public ceremony. At the time of the visit of the members of Section G of the British Association in September last, the steam launches, containing Sir J. Wolfe Barry and his visitors, were able to steam round the new dock through an opening made in the embankment. The dock is now open for traffic, and the five coal tips are available for use when required.

At Swansea the tender of Mr. George Nott has been accepted for making a new entrance to the South Dock. The new lock is to be 350ft. long, 60ft. wide, and 34ft. deep. When this lock is completed it will enable the half-tide basin to be used as a dock. The amount of the contract is stated to be £80,000. At Newport a recommendation of the Committee of the Harbour Commissioners that, in conjunction with the Corporation, they should seek powers in the Session of 1900 to construct training walls in the river Usk at Powder-house Point, at a cost of £17,800, has been approved. The Committee propose to begin low down the river near the mouth and work upwards, and thus by a system of training walls, combined with dredging, they consider that it will be possible to make the Usk practically as clean as a river could be with so many bends in it. Some opposition to the scheme was offered, the opponents contending that the river could be more efficiently improved by dredging among the accumulations at Powder-house Point; but it was shown that this without training would be labour in vain, as the accumulations would make up again as fast as they were cleared away.

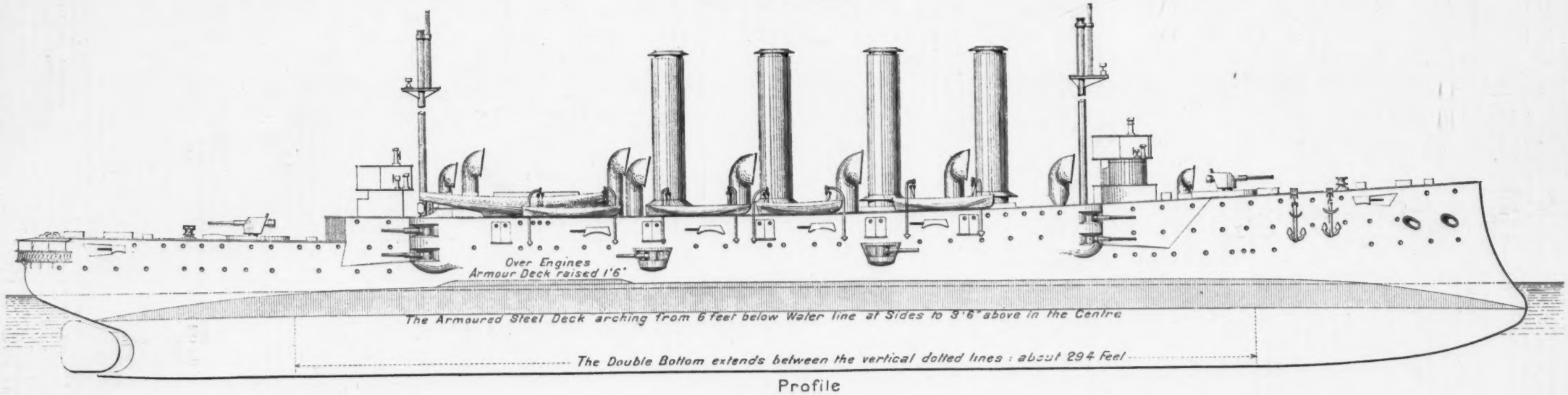
The Tyne.—The heavy gales which occurred during the autumn, being also accompanied by high tides, did considerable damage to the rubble work of the foundations of the South Pier, which now is in the same condition as that of the North Pier when it first began to yield. Mr. Walker, the engineer, has reported that if the necessary repairs to the rubble mound could be done without delay, and the covering blocks placed in position, there would be no ground for alarm; but as there is but little rubble in stock, and no Titan crane to place the heavy concrete blocks, and taking into account the difficulties of diving work during the stormy period of the winter, he considers the condition of the pier to be serious and dangerous. The engineer has been given full power by the Commissioners to carry out such works as he considers necessary to prevent further damage to the foundation work of the pier.

There appears to be some hitch between the Commissioners and the contractor for restoring the North Pier. It will be recollected that under the advice of Sir J. Wolfe Barry and Mr. Matthews the contract for restoring the damaged portion of the North Pier was given to Sir John Jackson, the plan selected, of the two submitted for consideration, being that by which the new pier is to be built on a straight line with the land portion of the existing pier, leaving the sea end of the present wall standing until the new pier is completed, and then to dismantle it to low water; the other scheme being to rebuild the new pier on the site of the present structure. The amount of the contract was £440,950, the time for completion being five and a-half years. Under the terms of the contract it was provided that a deposit of £10,000 should be made by the contractor by way of surety. Sir John Jackson declines to accept these terms on the ground that his firm for the last ten years have always declined to give surety in connection with any contracts, including a recent one for the Government involving an expenditure of £3,000,000.

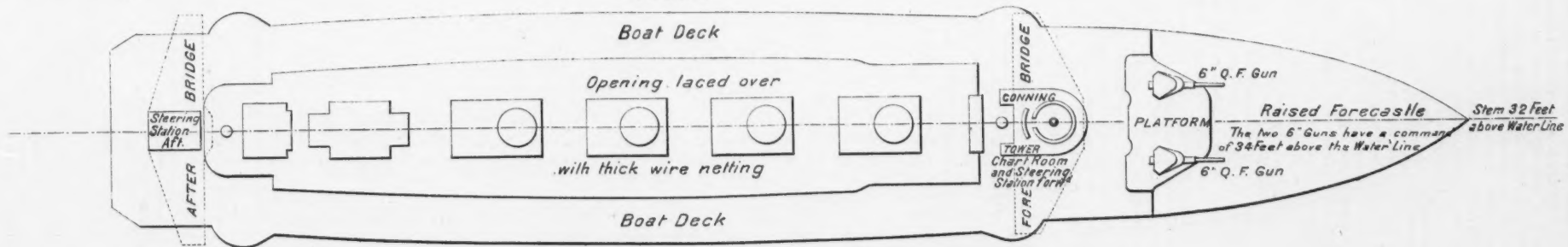
H. M. S. DIADEM

MESSRS. THE FAIRFIELD SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, GLASGOW, BUILDERS

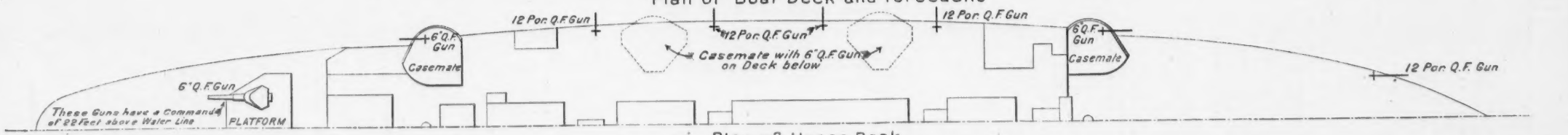
(*For description see page 641*)


Over Engines
Armour Deck raised 1'6"
The Armoured Steel Deck arching from 6 feet below Water line at Sides to 3'6" above in the Centre
The Double Bottom extends between the vertical dotted lines : about 294 Feet

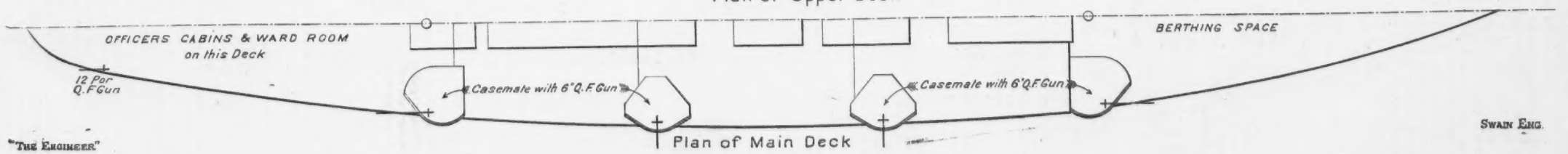
Profile



Plan of Boat Deck and Forecastle



Plan of Upper Deck



Plan of Main Deck

"THE ENGINEER"

SWAIN ENG.

THAMES SHIPBUILDING AND MARINE ENGINEERING.

HAVING, within the past fourteen months, given in the pages of this journal a consecutive, though necessarily brief, record of the progress of the sister arts of shipbuilding and marine engineering on the Thames during sixty years of an era—the Victorian—which will be in every sense historic, we have thought that a fitting appendix to the articles we gave on this subject, will be an approximate summary of the work done by the firms mentioned therein, which are still—with some exceptions—existent on the river; giving the most important of the work executed by them within the last twenty years, in tabular form, to enable our readers to see at a glance the increase of engine power in the ships of to-day, as compared with that in ships twenty years ago. Following this summary, and forming the most fitting conclusion to the subject, we shall give a short biographical memoir, with a likeness of each of those notable men who were the practical pioneers on the Thames of the two industries whose progress formed the subject of the series of articles above referred to. These brief memoirs are necessarily imperfect, from the lapse of time which has intervened since most of the subjects of them lived, and from the fact that their departure from the scenes of their labour has in many instances been without any permanent record.

Giving the several firms—herein noticed—engaged in shipbuilding and marine engineering on the Thames in the order of their establishment in business, and having in mind the fact that the first-named art, or "mystery," viz., shipbuilding, has precedence of its sister art on the river, the first firm claiming priority of place in our summary is that of Messrs. Green, of the Blackwall Yard at Poplar. This historic yard, as we recorded in the earliest of the series of articles above referred to, dates back to a time when shipbuilding was first permanently established as an industry on the Thames, that is to say, in the year 1587, when mention is first made of the laying out of Blackwall Yard. But it was not until 1797 that the founder of the present firm—Mr. Geo. Green—first commenced business as a shipbuilder therein. From that date up to the advent of Queen Victoria in 1837, some 128 of the finest ships that ever floated are authentically recorded as having been built in the yard, but a complete record of the ships constructed therein has not been kept.

From 1837 to 1877 an addition of 178 ships to the output from this yard is similarly recorded, twenty-four of these being for the British Navy; H.M.S. Glatton, built in 1855, and the Superb in 1866, being the first ironclad and first iron merchant ship, respectively, built in the yard. By the year 1877 great changes had taken place in the shipbuilding trade of the river, few sailing ships being built, while iron had in a large measure superseded wood as the material of ship construction. Above we give in tabulated form the principal vessels built at the Blackwall Yard between 1878 and 1898, all of them being steamships, having engines above 100-horse power, the majority of them supplied by Thames engineers.

In addition to the above enumerated vessels, Messrs. Green have within the dates given constructed numerous small craft for Thames river purposes, and several large lightships for the Trinity Corporation, the Brazilian and other foreign Governments, the total recorded output of vessels of all classes from their shipyard from 1837 to the present time being about 490 in number. It will be noticed that—with two or three exceptions—most of the ships built by this firm since it commenced the use of iron as the constructive material have been of small tonnage and horse-power; the transition from wood to iron construction having, in the case of most wooden shipbuilders, necessitated their confining themselves at first to comparatively small vessels.

The only departure in type of vessel to be specially noticed in Messrs. Green's constructions during the last ten years is that of the designing and building of the first steam lifeboat, the Duke of Northumberland, the principal peculiarity in the design being its mode of propulsion by means of the water-jet propeller. As this boat and its propelling machinery were fully described and illustrated in this journal at the time of construction, no further reference to it is needed here.

The firm next in order of place in our summary is that of Messrs. Maudslay, Sons, and Field, now long established as marine engineers in Lambeth, the date of Mr. Maudslay's commencement of business in that locality being the year 1810. It was not, however, till about the momentous year 1815 that the firm gave special attention to marine engineering, they having in that year fitted the first steam vessel, the Richmond, that plied for hire on the Thames. Up to the year 1837 some seventy-three vessels had been fitted by the firm with machinery, the propelling instrument in all cases being the paddle-wheel. From 1837 to 1877 the output of marine engines—the typical engines of which, both screw and paddle, we have noted and described in our late series of articles—was about 515 pairs in number. In tabular form below we give a list of the principal ships fitted by Messrs. Maudslay, Sons, and Field, with the indicated power of their engines and the service in which they were employed, during the twenty years ending 1898, no engines under 1000 indicated horse-power being included.

Principal Ships built by Messrs. Green, from 1878 *to* 1898, *at Blackwall Yard.*

Date.	Name.	Paddle or screw.	Dimensions. Length.	Breadth.	Depth.	Horse-power.	Gross tonnage.	Trade or employ.
			ft. in.	ft. in.	ft. in.		tons.	
1879	Guiana	Paddle	175 0	19 0	8 0	420	241	British Guiana
,,	Norfolk	Screw	320 0	40 1	32 9	3000	3254	Messrs. Money Wigram and Co.
1880	Active	,,	60 0	14 0	7 0	120	—	Colonies (Colombo)
,,	Charlestown	Paddle	105 0	16 0	8 0	189	176	British Guiana
1881	Puerto Huergo	Screw	65 0	14 0	8 0	120	—	Buenos Ayres
,,	Sprotson Wood	Paddle	115 0	16 0	7 3	191	—	Demerara
,,	J. Searle	Screw	70 0	16 0	8 6	150	56	Algoa Bay (towing)
,,	Name unknown	Paddle	110 0	19 0	6 9	170	189	Sydney, N.S.W.
,,	Bergamo	Screw	70 0	15 0	8 6	160	73	Buenos Ayres
1882	Tomki	Twin screw	180 0	27 0	15 0	575	635	Sydney, N.S.W.
,,	Suffolk	Screw	300 0	40 0	31 0	1600	2924	Messrs. Hooper and Co.
,,	Henry Wright	,,	80 0	16 0	8 6	200	—	Zanzibar (Mission)
,,	H.M.S. Sphinx	Paddle	200 0	32 0	14 7	1138	790	Persian Gulf Station
1883	Hornet	Screw	75 0	14 6	7 10	120	—	Messrs. Pickford and Co.
,,	Seabelle	,,	160 0	25 0	12 6	850	670	Straits Settlements
,,	Fulton	,,	70 0	15 0	10 0	150	96	Buenos Ayres
,,	Tepic	,,	70 0	16 0	8 9	150	92	Mexico
1884	Cuyuni	,,	80 0	16 0	9 5	300	78	Demerara
,,	Woodcock	,,	90 0	20 0	11 0	375	—	Thames (towing)
,,	Cotentin	,,	97 0	18 0	8 6	175	—	Portbail and Jersey
,,	Awarua	Paddle	120 0	20 0	10 0	400	159	Bluff Harbour, New Zealand
,,	Escort	Screw	53 6	12 6	7 3	134	—	Diego Garcia (towing)
1888	Monarch	Paddle	210 0	22 0	9 0	850	348	Bournemouth Passenger Service
1889	Gordon	,,	164 6	42 1	6 3	600	493	Woolwich Free Ferry
,,	Duncan	,,	164 6	42 1	6 3	600	493	Woolwich Free Ferry
,,	Duke of Northumberland	Jet	50 0	12 0	5 6	170	21	Steam Lifeboat, R.N.L.B.I.
1890	Chukran	Paddle	165 0	21 0	10 0	580	244	Bosphorus Passenger Service
,,	Ibsoen	,,	165 0	21 0	10 0	580	244	Bosphorus Passenger Service
,,	Ellen	Screw	75 0	14 6	8 6	239	—	Thames (towing)
,,	H.M.S. Asp	,,	115 0	21 0	10 0	300	330	Fire Float, Sheerness
,,	Princess Alice	,,	180 0	27 0	16 9	350	555	Yacht for Prince of Monaco
1891	Duchess of Devonshire	Paddle	170 0	20 0	8 1	400	221	Exmouth Passenger Service
,,	Teneriffe	Screw	70 0	16 0	6 7	180	52	Island of Teneriffe
,,	Expert	,,	86 9	18 0	10 4	420	100	Thames (towing)
1892	Palm	Paddle	125 0	20 0	6 9	120	137	Thames Steamboat Company
,,	Orchid	,,	125 0	20 0	6 9	120	137	Thames Steamboat Company
1893	City of Glasgow	Jet	53 0	15 2	5 6	200	—	Steam Lifeboat, R.N.L.B.I.
,,	City of Adelaide	,,	53 0	15 2	5 6	200	—	Steam Lifeboat, South Australia
,,	United	Twin screw	104 0	21 0	12 0	600	163	Towing (East London S.A.)
1894	Ikdam	Paddle	165 0	21 0	9 5	640	244	Bosphorus Passenger Service
,,	Intizam	,,	165 0	21 0	9 5	640	244	Bosphorus Passenger Service
,,	Cecil Rhodes	Twin screw	104 0	21 1	11 2	600	160	Towing (East London S.A.)
1895	Duchess of York	Paddle	270 0	30 0	14 5	3800	996	Folkestone to Boulogne, S.E.R.
,,	Chirket-i-Hairi (2)	,,	165 0	21 1	9 5	620	240	Bosphorus Passenger Service
1896	Duke of Devonshire	,,	175 0	20 6	8 2	400	257	Exmouth Passenger Service
1898	Conservator	Twin screw	133 6	19 1	10 8	400	222	Yacht for Thames Conservancy

Principal Ships Engined by Messrs. Maudslay, Sons, and Field, from 1878 *to* 1898.

Date.	Name of ship.	I.H.P.	In what service engaged.
1878	Doterel	1,130	British Government
,,	Kingfisher	1,120	,, ,,
1879	Colossus	7,497	,, ,,
,,	Almirante Brown	5,377	Argentine Navy
,,	Espiegle	1,140	British Navy
,,	Mutine	1,126	,, ,,
,,	Grand Duchess Olga	1,725	Russian Steam Nav. Co.
1880	Himalaya	2,578	British Troopship
,,	Pouskin	1 617	Russian Steam Nav. Co.
1881	Rapid	1 400	British Navy
,,	Royalist	1,519	,, ,,
,,	Caroline	1,439	,, ,,
1882	Tamar	2,875	British Troopship
,,	Amphion	5,650	British Navy
,,	Impérieuse	10,184	,, ,,
,,	Ruggiero di Lauria	11,000	Italian Navy
,,	Benbow	11,700	British Navy
1883	Camperdown	11,700	,, ,,
,,	Andrea Doria	11,000	Italian Navy
1885	Stephanie	11,000	Austrian Navy
,,	Re Umberto	20,000	Italian Navy
1886	Nile	12,000	British Navy
,,	Sicilia	20,000	Italian Navy
1887	Sandfly	3,000	British Navy
,,	Spider	3 000	,, ,,
,,	Grasshopper	3,000	,, ,,
,,	Salamander	4,500	,, ,,
,,	Seagull	4,500	,, ,,
,,	Sheldrake	4,500	,, ,,
1888	Temeraria	2,600	Spanish Navy
,,	Almirante Tamandare	7,500	Brazilian Navy
,,	Cataluna	15,000	Spanish Navy
,,	Blake	20,000	British Navy

Ships Engined by Messrs. Maudslay, Sons, and Field (continued).

Date.	Name of ship.	I.H.P.	In what service engaged.
1888	Plassy	4,500	Indian Government
,,	Assaye	4 500	,, ,,
,,	Liguria	6,500	Italian Navy
,,	Minerva	4,000	,, ,,
,,	Thunderer	7,000	British Navy
,,	Devastation	7,000	,, ,,
1889	Marco Polo	10,000	Italian Navy
,,	Sirius	9,000	British Navy
,,	Spartan	9,000	,, ,,
,,	Theseus	12,000	,, ,,
,,	Royal Arthur	12,000	,, ,,
,,	Cruiser	15,000	Spanish Navy
1890	George Victorious	15,000	Russian Navy
,,	Gremyaschi	2,000	,, ,,
1892	Monarch	8,000	British Navy
,,	Dryad	3,500	,, ,,
,,	Carlo Alberto	13,000	Italian Navy
,,	Admiral Oushakoff	5,000	Russian Navy
1893	Carlos V.	18,500	Spanish Navy
,,	Princessa di Asturcas	15,000	,, ,,
,,	Garibaldi	13,000	Argentine Navy
,,	Saint Bon	13 500	Italian Navy
,,	Renown	12,000	British Navy
,,	Conflict	4,500	,, ,,
,,	Teazer	4,500	,, ,,
,,	Wizard	4,500	,, ,,
1894	Zebra	4,500	,, ,,
,,	Cristobal Colon	13,000	Spanish Navy
,,	Cæsar	12,000	British Navy
1895	Gladiator	10,000	,, ,,
1896	Albion	13,500	,, ,,
,,	Spartiate	18,000	,, ,,
1897	Guiseppe Garibaldi	13,000	Itanan Navy
1898	Irresistible	15,000	British Navy
,,	Venerable	15,000	,, ,,

From the above record of principal vessels engined by Messrs. Maudslay, Sons, and Field within the dates 1878 to 1898, our readers will not be surprised when informed that this firm in the years covered by the Victorian Era up to the end of 1898 has fitted some 570 vessels of all classes with propelling machinery; its engines aggregating a total of 1,064,850 indicated horse-power. Of these 179 were paddle-wheel ships, the remainder being screw vessels, of which eighty-three were gun and despatch boats, eleven torpedo boats, and twenty-three steam launches; the first large paddle vessel being the Great Western—the first successful Atlantic steamship—engined by the firm in 1838; and the first screw ship, H.M.S. Rattler, engined in 1841, she being the first screw-propelled vessel in the British Navy.

The next firm to be included in our summary in order of precedence is that of Messrs. Jno. Penn and Sons, of Greenwich, the founder of which started in business as a millwright in a small shop on the site of the present extensive works, about the year 1804. It is, however, to his son, the late Mr. Jno. Penn—father of the present members of the firm—that the steamship-owning community is indebted for great improvements effected in steamship machinery. The first marine engines made at Greenwich were for the steamer Ipswich in 1825, to run between London and Ipswich and up the river Orwell. They were side-lever engines of about 40-horse power.

Principal Ships Engined by Messrs. Jno. Penn and Sons, 1878 *to* 1898.

Date.	Name of ship.	I.H.P.	In what service engaged.
1878	Agostin Barbarigo	1,826	Italian Government
,,	Naiseadnik	1,704	Baltic Steam Nav. Co.
,,	Foo-so	3,824	Japanese Navy
,,	Northampton	6,010	British Navy
,,	Neptune	8,832	,, ,,
1880	Albert Victor	2,823	S.E.R. Passenger Service
,,	Louise Dagmar	2,800	,, ,,
,,	Tchihatchoff	800	Russian Steam Nav. Co.
1881	Constance	2,595	British Navy
,,	Navarra	4,400	Spanish Government
,,	Castilla	4,000	,, ,,
,,	Flavio Gioia	4,700	Italian Government
1882	Lepanto	16,500	,, ,,
,,	Italia	14,000	,, ,,
,,	Mary Beatrice	2,918	S.E.R. Passenger Service
,,	Sphinx	1,138	British Navy
1883	Agamemnon	6,366	,, ,,
,,	Ajax	6,439	,, ,,
,,	Tilbury	405	Tilbury and Southend Railway Co.
1885	Reina Mercedes	4,800	Spanish Government
,,	Reina Cristina	4,800	,, ,,
,,	Thames	5,885	British Government
,,	Curlew	1,262	,, ,,
1886	Landrail	1,250	,, ,,
1888	Monarch	934	Weymouth Co. Pass. Ser.
,,	Warspite	10,241	British Navy
1889	Gordon	682	Woolwich Free Ferry
,,	Duncan	658	,, ,,
,,	Shahin	580	Turkish Government
,,	Chirket-i-Hairi (2)	580	Bosphorus Pass. Service
1891	Duchess of Devonshire	398	Exmouth Steamship Co.
,,	Mermaid	344	Thames Victoria S.B. Co.
,,	Princess Alice	390	Yacht for Prince of Monaco
,,	Sappho	9,617	British Government
1892	Scylla	9,280	,, ,,
,,	Circe	3,508	,, ,,
,,	Alarm	3,597	,, ,,
,,	Ledo	3,597	,, ,,
,,	Crescent	10,377	,, ,,
1894	Chirket-i-Hairi (2)	620	Bosphorus Pass. Service
1895	Magnificent	12,173	British Government
,,	Duchess of York	4,300	Folkestone to Boulogne, S.E.R. Co.
1896	Duke of Devonshire	590	Exmouth Steamship Co.
1897	Pactolus	7,200	British Government
,,	Pomone	7,000	,, ,,
1898	Goliath	13,500	,, ,,
,,	Illustrious	12,126	,, ,,

As steamers soon began to run regularly on the Thames between London and Greenwich, Messrs. Penn got their share of fitting them with engines; but it was not till about the commencement of the Victorian Era, or in 1838, that the firm began to make the special types of marine engines so intimately associated with its name. From that year to the present time Messrs. Penn and Sons have engined some 760 vessels of all classes, having

an aggregate of 815,445 indicated horse-power. Many of those engined in the early years of the era were of small size and engine power; but the firm fitted within the time covered between 1838 and the present year 261 pairs of oscillating engines, ranging from 15 to 800-horse power, and 224 pairs of trunk engines from 15 to 1350-horse power. Above we give a similar record to that of Messrs. Maudslay and Co., showing the principal vessels, with horse-power, &c., engined by Messrs. Penn and Sons within the last twenty years, no engines being included in it under 300 indicated horse-power.

Several large dredgers were also constructed for home and foreign navigation companies. The firm was also specially noted for the building of State yachts, among them being the river service yacht of the Grand Duke of Russia, the State yachts of the Sultan of Turkey, the Khedive of Egypt, and the Emperor of Austria, and the private yachts for Sir Robert Peel and other gentlemen. The firm also made a speciality of the bending and machining of armour plates, not only for the warships constructed by themselves, but for some of the makers of armour-plate for vessels building in her Majesty's dock-

Principal Vessels built by Messrs. Samuda Brothers, 1870 to 1892.

Date.	Name of vessel.	Paddle or screw.	Dimensions. Length.	Beam.	Depth.	Displacement.	Service engaged in.
			ft. in.	ft. in.	ft. in.	tons.	
1870	Unknown	Paddle	130 0	20 0	7 0	124	Sir S. Baker's Nile Expedition
,,	Louisa	Screw	200 0	26 6	19 0	1520	Cargo carrying
1871	Heptarchy	,,	200 0	26 6	19 0	1520	,, ,,
,,	Douai	,,	210 0	29 0	11 0	965	,, ,, for Russia
,,	M. Proot	,,	210 0	29 0	11 0	965	,, ,, ,,
1872	Miramar	,,	270 0	34 0	25 5	1815	Austrian State Yacht
,,	Cesarevna	,,	250 0	32 0	17 6	1525	Russian Passenger Steamer
,,	Medveditza	,,	210 0	29 0	11 0	861	Russian cargo carrying
,,	Ingul	,,	210 0	29 0	11 0	861	,, ,, ,,
,,	Dnieper	,,	210 0	29 0	11 0	861	,, ,, ,,
1873	Florentin	,,	240 0	33 0	24 6	2080	Italian cargo carrying
1874	Kaiser	,,	280 0	62 0	19 8	7550	Armour-clad, German Navy
,,	Deutschland	,,	280 0	62 0	19 8	7550	,, ,, ,,
1876	Belleisle	,,	245 0	52 0	22 0	3075	Armour-clad, British Navy
,,	Orion	,,	245 0	52 0	22 0	3075	,, ,, ,,
1877	Foo-So	,,	220 0	48 0	20 4	2343	Armour-clad, Japanese Navy
,,	Victoria	Paddle	100 0	20 0	11 7	187	Towing (Thames)
,,	Glenbrook	,,	134 0	15 6	8 1	119	Cork Passenger Boat
1878	Alexandra	,,	100 0	20 0	11 9	—	Towing (Thames)
,,	Bridegroom	,,	110 0	13 9	6 6	—	Thames Passenger Boat
,,	Wedding Ring	,,	110 0	13 9	6 6	—	,, ,, ,,
1879	Almirante Brown	Screw	240 0	50 0	23 11	4333	Armour-clad, Argentine Navy
1880	Count Todleben	Paddle	212 0	25 0	14 6	645	Russian Passenger
,,	Louise	,,	100 0	20 6	11 9	—	Towing (Thames)
,,	Albert Victor	,,	250 0	29 0	15 6	806	Passenger Service, South-Eastern Rly.
,,	Louise Dagmar	,,	250 0	29 0	15 6	806	,, ,, ,, ,,
1881	Beatrice	,,	100 0	20 6	11 9	—	Towing (Thames)
1882	Mary Beatrice	,,	255 0	29 0	15 6	833	Folkestone and Boulogne Pass. Service
,,	Starling	Screw	125 0	23 6	12 0	465	Gunboat, British Navy
,,	Stork	,,	125 0	23 6	12 0	465	,, ,, ,,
,,	Raven	,,	125 0	23 6	12 0	465	,, ,, ,,
,,	Haidar Pasha	Paddle	155 0	22 0	10 5	262	Turkish Government Passenger Service
1883	Riachuelo	Screw	305 0	52 0	26 3	5713	Armour-clad, Brazilian Navy
,,	Imperatrulu	Paddle	215 0	24 0	9 10	411	Russian Passenger Service on Volga
,,	Aquidaban	Screw	280 0	52 0	24 9	4982	Armour-clad, Brazilian Navy
1887	Achille Adam	Twin screw	190 0	27 0	13 1	625	Folkestone and Boulogne Pass. Service
,,	Jubilee	Screw	120 0	20 0	10 6	215	Cargo Boat, South-Eastern Railway Co.
,,	Shahini	Paddle	180 0	22 0	8 6	262	Bosphorus Passenger Steamer
1891	Sappho	Twin screw	300 0	43 0	23 0	3415	Cruiser, British Navy
,,	Scylla	,,	300 0	43 0	23 0	3415	,, ,, ,,
,,	Bismarck	Paddle	120 0	16 0	7 4	—	Thames Passenger Boat
,,	Empress Frederick	,,	120 0	16 0	7 4	—	,, ,, ,,
,,	Mermaid	,,	160 0	20 0	8 6	150	,, ,, ,,
,,	Mylota	,,	150 0	18 6	9 0	130	Passenger Steamer, S.E. Railway Co.
,,	Edward William	,,	150 0	18 6	9 0	130	,, ,, ,, ,,

The firm next in order of place in our summary is that of Messrs. Samuda Brothers, engineers and shipbuilders, of Poplar, who entered into partnership as marine engine builders in 1832, but afterwards took up shipbuilding in iron and steel, their first vessel being the unfortunate Gipsy Queen, on board of which, on November 12th, 1844, the senior partner of the firm—Mr. Jacob Samuda—unhappily met his death in the way recorded in our early serial articles. Up to the year 1870 about 55 vessels of all classes had been built, but few engined at Messrs. Samuda's works and shipyard, and from that date to their close in 1892 all vessels over 100 tons displacement built by the firm are enumerated in the above tabular statement, their engines being mostly supplied and fitted by one or other of the marine engine firms on the river.

In addition to the above principal vessels built by Messrs. Samuda's firm during the last twenty years of its existence, a large amount of work was done at their shipyard in the shape of powerful floating derricks and cranes, notably the Elephant, Titan, and Leviathan, for the East and West India Dock Companies, the two latter craft being considerably over 400 tons displacement.

yards and in private shipbuilding establishments, there being at the time a great pressure of work of the kind, and Messrs. Samuda the only shipbuilders having the necessary plant and experience.

Following on in the order of date of establishment, the next firm to claim attention in our summary is that of Messrs. Ditchburn and Mare, who in 1836-7 started the Orchard Shipyard at Blackwall, on a part of the premises now known as the Thames Ironworks. Many good ships were built in the early days of this yard, both of wood and iron; but a few years after its establishment

Principal Ships Built by the Thames Ironworks Co., at Blackwall, 1877 to 1898.

Date of launch	Name of vessel.	Dimensions. Length.	Breadth.	Depth.	Displacement.	Whom built for.	Type or class.
		ft. in.	ft. in.	ft. in.	tons.		
1877	Superb	332 3	59 0	40 8	8,994	British Government	Central Battery
,,	Dom Augusta	165 0	18 0	8 6	166·8	Portuguese Government	Gun Vessel
,,	Principe Dom Carlos	130 0	20 0	14 6	435·0	,, ,,	,, ,,
1878	Somtsew	90 0	17 6	7 3	114·5	South Africa ,,	Private use
,,	Faro	95 0	16 0	10 11	150·3	Portuguese Government	Despatch Boat
,,	Tejo	108 0	17 6	11 6	228·9	,, ,,	,, ,,
,,	Stour	125 0	17 6	7 0	107·1	Great Eastern Railway Co.	Passenger Boat
1879	Zieten	226 0	28 0	18 6	951·3	German Government	Torpedo Cruiser
,,	Principe Gras Paro	220 0	27 0	17 0	930·7	South America	—
,,	Swift	165 0	29 0	14 3	767·3	British Government	Composite Gunboat
1880	Linnet	165 0	29 0	14 3	767·3	,, ,,	,, ,,
,,	D'Affonso	158 0	18 0	8 6	146·0	Portuguese Government	Gunboat
1881	Gravina	210 0	32 0	17 6	1,139·0	Spanish Government	Cruiser
,,	Velasco	210 0	32 0	17 6	1,139·0	,, ,,	,,
1882	Invicta	312 0	33 3	17 3	1,282·2	L.C. and D. Railway Company	Mail Steamer
,,	Mircea	118 0	25 0	14 6	390·1	Roumanian Government	Training Brig
1884	Alfonso D'Albuquerque	205 0	33 0	18 0	1,111·6	Portuguese Government	Corvette
,,	Alpheios	130 0	25 0	14 6	421·8	Greek Government	Cruiser
,,	Acheloos	130 0	25 0	14 6	421·8	,, ,,	,,
1885	Benbow	330 0	68 6	37 2	10,011	British Government	Battleship
1887	Sanspareil	340 0	70 0	37 2	10,538	,, ,,	,,
1890	Blenheim	375 0	65 0	41 0	9,038·7	,, ,,	Cruiser, 1st class
,,	Chirket-i-Hairi	170 0	21 2	10 10	284·3	Bosphorus Company	Passenger Steamer
1891	Grafton	360 0	60 0	39 5	7,350	British Government	Cruiser, 1st class
1892	Theseus	360 0	60 0	39 5	7,350	,, ,,	,, ,,
1895	Zebra	200 0	20 0	12 9	303·5	,, ,,	Torpedo Destroyer
,,	Samoyed	170 0	33 0	16 7	983·3	Russian Government	Surveying Vessel
1896	Fuji	374 0	73 0	44 9	12,512	Japanese Government	Battleship
1898	Shikishima	400 0	75 6	45 3	14,850	,, ,,	,,
,,	Albion	390 0	74 0	44 0	13,000	British Government	,,
,,	Alexandra	120 0	17 0	7 9	88·5	Thames Steamboat Company	Passenger Boat
,,	Boadicea	120 0	17 0	7 9	88·5	,, ,,	,, ,,
,,	Cleopatra	120 0	17 0	7 9	88·5	,, ,,	,, ,,

Mr. Mare, the junior partner in the firm—Mr. Ditchburn being his senior by some fifteen years—conceived the idea of starting new works on the opposite, or Essex, side of Bow Creek, and laying down plant for making their own iron, as the best London "scrap" was then to be had in abundance. This suggestion led to a rupture of the subsisting partnership, and Mr. Mare started alone the nucleus of what subsequently became the Thames Ironworks. Many fine ships were built therein up to the time of the Crimean war, or until the year 1856, when, having taken some fifteen gun and despatch boats to construct at too low a price, Mr. Mare retired from business, and the following year the Thames Ironworks and Shipbuilding Co. was formed. Up to this date—1857—some hundreds of vessels of all sizes and types had been built; but it is within the last twenty years that the company has been principally engaged in building warships for the British Navy. Of the many vessels built at the Orchard Yard from 1877 to 1898, we give the most important in the preceding tabular statement of their names, dimensions, displacement, &c.

Although the vessels enumerated in the above list aggregate little more than 106,000 tons of tonnage displacement, the list includes several of the finest ships of their time and type ever built, notably the Benbow, Sanspareil, Blenheim, Grafton, Theseus, and Albion, for the British Navy; and the Fuji and Shikishima for the Imperial Japanese Government; the two first-mentioned battleships carrying, at the date of their construction, two 110-ton and two 113-ton guns respectively—the only guns of that weight then existent in the Navy. It is, however, only lately, as before remarked, that the Thames Ironworks Company has principally been engaged in warship building, for the record of vessels built in its shipyard covers all classes and types of craft that float upon the waters, from the monster battleship to the vedette boat, or the sumptuous passenger steamer or cargo vessel to the lowly barge. This is strongly in evidence when we are credibly informed that over 850 vessels above 50ft. in length, having a displacement tonnage of nearly half a million tons, have been constructed at the Thames Ironworks shipyard since its establishment: and, what is also a remarkable and noteworthy fact, that fully half this tonnage has been designed by the present veteran naval architect to the company, Mr. Geo. C. Mackrow, who was articled in 1843 to the original founders of the Orchard Shipyard, to learn the "art and mystery" of ship construction, and has continued there ever since.

Messrs. Humphrys, Tennant, and Co., of Deptford, the firm next claiming notice in order in our summary, is one the founder of which helped so largely in making the marine engine as we find it to-day, during the twelve years following the outbreak of the Crimean war; as it was in the year 1852 that the late Mr. Edward Humphrys, with his partners, started in business as marine engine builders in the premises then lately occupied by Messrs. Rennie, at Deptford. As recorded in Article XIV. of the series before referred to, the first work of the firm was on engines for the Danube Steam Navigation Co., but the improvements in the arrangement and details of marine machinery introduced by Mr. Humphrys soon materially increased the business. Up to the year ending 1897 no less than 337 vessels of all classes have been fitted with their propelling machinery from Messrs. Humphrys and Co.'s works. From 1877 to the present date the above tabulated list of the principal ships fitted, with the horse-

Principal Ships Engined by Messrs. Humphrys, Tennant, and Co. 1877 to 1898.

Date.	Name of ship.	I.H.P.	In what service engaged.
1877	Alexandra	8,000	British Navy
,,	Temeraire	7,000	,, ,,
1878	Vasco da Gama	3,200	Portuguese Navy
,,	Curaçoa	2,300	British Navy
1879	Conquest	2,300	,, ,,
,,	Cleopatra	2,300	,, ,,
,,	Serapis	4,200	,, ,,
,,	Crocodile	4,200	,, ,,
1881	Polyphemus	5,500	,, ,,
,,	Gravino	1,800	Spanish Navy
,,	Velasco	1,800	,, ,,
1883	Conqueror	4,500	British Navy
,,	Edinburgh	6,000	,, ,,
1884	Collingwood	7,000	,, ,,
,,	Riachuelo	6,000	Brazilian Navy
,,	Aquidaban	4,500	,, ,,
,,	Infanta Isabel	1,800	Spanish Navy
,,	Don Juan d'Austria	1,800	,, ,,
1885	Mersey	6 000	British Navy
,,	Rodney	6,000	,, ,,
1886	Howe	9,500	,, ,,
,,	Severn	6,000	,, ,,
,,	Chin Yuan	5,500	Chinese Navy
,,	Ching Yuan	5,500	,, ,,
1887	Anson	10,000	British Navy
1888	Victoria	12,000	,, ,,
,,	Sanspareil	12,000	,, ,,
,,	Medea	9,000	,, ,,
1889	Trafalgar	12,000	,, ,,
,,	Medusa	9,000	,, ,,
,,	Piemonte	11,600	Italian Navy
1890	25 de Mayo	14,500	Argentine Navy
,,	Superb	8,500	British Navy
1891	Vulcan	12,000	,, ,,
1892	Blenheim	20,000	,, ,,
,,	Royal Sovereign	13,000	,, ,,
,,	Hood	13,000	,, ,,
1893	Empress of India	13,000	,, ,,
,,	Repulse	13,000	,, ,,
,,	Grafton	12,000	,, ,,
,,	9 de Julio	14,500	Argentine Navy
,,	Yoshino	15,750	Japanese Navy
1894	Blanco Encalada	14,500	Chilian Navy
1895	Buenos Aires	17,000	Argentine Navy
1896	Tir Sviahlelia	10 600	Russian Navy
,,	Admiral Seniavin	5,000	,, ,,
,,	Prince George	12,000	British Navy
,,	Ministro Lentino	7,500	Chilian Navy
,,	Esmeralda	18,000	,, ,,
1897	Fuji	13,500	Japanese Navy
,,	Yashima	13,500	,, ,,
,,	New Orleans	7,500	United States (America)
,,	Barozza	7,500	Brazilian Navy
1898	Poltava	10 600	Russian Navy
,,	O'Higgins	16,000	Chilian Navy
,,	Takasago	15,750	Japanese Navy
,,	Asama	18,000	,, ,,
,,	Tokiwu	18,000	,, ,,
,,	Battleship	14,500	,, ,,
,,	Shikishima	14,500	,, ,,
,,	Cruiser	14 500	,, ,,
,,	Cruiser	14,500	,, ,,
,,	Royal Yacht	11,000	Her Britannic Majesty

power of their engines, &c., will give an idea of the class and amount of work turned out by the firm in the time, none of the vessels included having engines of less than 1000 indicated horse-power.

In the foregoing list of sixty-three ships, with a total of 611,500 indicated horse-power of engines, it will be seen are included some of the largest and most powerful warships in the world, and that Messrs. Humphrys and Co. have been the means of providing propelling machinery for the ships of the British, Japanese, Russian, Spanish, Brazilian, Portuguese, Argentine, and Chilian navies, a special fact to be noted being that the majority of the ships are of exceptionally large engine power.

The work of the last firm included in our summary of ordinary vessels is that of Messrs. J. and W. Dudgeon, engineers and shipbuilders, until the year 1875 carrying on business at Cubitt Town and Millwall; a firm which, although of brief existence, still added materially to the advancement of marine engineering and steam navigation. Commencing business in 1855 at the Sun Iron-works, Millwall, as marine engine builders only, this firm in 1862 added that of shipbuilding, which was carried on at Cubitt Town, where there was built in that year the first twin-screw steamship, the Flora, described and illustrated in our issue of June 3rd last, the system of ship propulsion by independently-driven twin screws having cylinder being 12¾in. diameter, and the low-pressure 21in., with a 12in. piston stroke. The engines drove a single screw, and gave the vessel a speed of 18½ knots an hour. In the same year Messrs. Yarrow and Co. delivered a similar vessel, 86ft. long by 11ft. beam, to the British Admiralty, fitted with compound engines and a single screw, the speed on trial being 20¾ knots. From the date of the introduction of these two pioneer vessels into our Navy both the firms mentioned have constructed a large number of torpedo vessels of all sizes, not only for our own Government, but for all the naval Powers in the world.

As Messrs. Thornycroft and Co.'s firm was first established, we give on p. 639 a statement in tabulated form of the principal vessels of the torpedo boat type built by it between the years 1877 and 1898, followed by a similar statement of those built by Messrs. Yarrow and Co. within the same dates, noting in each the names of some of the typical vessels as they were originated at the two shipyards.

In the foregoing brief summary of work done by the principal firms of shipbuilders and marine engineers in the Thames district during sixty years of Queen Victoria's reign, our elder readers will note that no record is given of some firms that are now non-existent. This omission is consequent on our having been unable to obtain any

Principal Steamships Built by Messrs. J. and W. Dudgeon, 1861 to 1875.

Date.	Name of vessel.	Paddle or screw.	Tonnage.	H.P. nom.	Intended service.
1862	Flora	Twin screw	366	120	Blockade Runner
,,	Comte Cavour	Screw	124	30	Italian Coasting Trade
1863	Kate	Twin screw	425	120	Blockade Runner
,,	Hebe	,,	425	120	,, ,,
,,	Don	,,	425	120	,, ,,
,,	Edith	,,	531	200	,, ,,
,,	Dee	,,	425	120	,, ,,
,,	Ceres	,,	425	120	,, ,,
,,	Vesta	,,	425	120	,, ,,
,,	Annie	,,	425	120	,, ,,
,,	Far East	,,	1258	150	China Tea Trade (Auxiliary)
1864	Atalanta	,,	543	200	Blockade Runner
,,	City of Richmond	Paddle	829	200	,, ,,
,,	Virginia	,,	829	200	,, ,,
,,	Zealous	,,	822	200	Great Eastern Railway Company
1865	Rushine	Twin screw	1596	3 0	Panama and New Zealand Mail
,,	Ipswich	Paddle	125	40	Great Eastern Railway Company
,,	Stour	,,	125	40	,, ,,
,,	Nimble	Twin screw	138	40	Gunboat, Dutch Navy
,,	H.M.S. Viper	,,	737	160	British Navy, Ironclad Gunboat
,,	Run Her	Paddle	829	200	Blockade Runner
,,	Rattlesnake	Twin screw	592	200	,, ,,
,,	Mary Augusta	,,	972	300	,, ,,
,,	L. Ann Fanny	,,	972	300	,, ,,
,,	Mary	,,	829	250	,, ,,
,,	John Wells	,,	436	120	Goole and Antwerp
,,	Avalon	Paddle	837	200	Great Eastern Railway Company
,,	Ravensbury	,,	867	200	,, ,,
,,	Thames	,,	138	50	Towing (Thames)
1866	Medusa	Twin screw	1161	200	Brazilian Navy, Ironclad Gunboat
,,	Triton	,,	1161	200	,, ,,
,,	Jupiter	Paddle	218	60	River Passenger, Australia
1867	Liguria	Screw	230	60	Italian Coasting Trade
,,	Eugenie	Twin screw	300	60	Gunboat, Japanese Navy
,,	Honda	Screw	275	60	,, ,,
,,	Assunta	,,	275	60	,, ,,
1869	Manuelita	,,	700	200	Gunboat, Chinese Navy
,,	Abyssinia	Twin screw	1854	200	Ironclad Monitor, British Navy
,,	Pepita	,,	355	80	Gunboat, Chinese Navy
,,	Conchita	,,	355	80	,, ,,
,,	Spindrift	Paddle	230	70	Towing (River Thames)
1870	Italo Platense	Twin screw	1535	275	River Plate, Passenger and Mails
,,	La Pampa	,,	1535	275	,, ,,
,,	Tenasserina	Screw	1492	251	Transport for Indian Navy
,,	Lulio	,,	800	150	Barcelona and Balearic Isles
1871	Hecate	Twin screw	2107	250	Ironclad, British Navy
,,	King Masaba	,,	501	60	River Niger Service
,,	Richard Young	Paddle	867	220	Great Eastern Railway Company
1872	Pasago	Screw	829	150	Spanish Coasting Trade
,,	Santander	,,	2014	350	Spanish Transatlantic Mail
,,	Hoper	Twin screw	861	60	Black Sea and Danube
,,	Alma	,,	861	60	,, ,,
,,	Salghir	,,	861	60	,, ,,
,,	Enterprise	Screw	609	150	British Indian Navy
,,	Union	,,	301	70	West India Trade
1873	Chatham	,,	378	80	Dover and Calais Goods Service
,,	Gunboats (2)	Twin screw	250	30	Siamese Navy
,,	Swithiod	Paddle	554	120	Baltic Passenger Service
,,	Gauthiod	,,	554	120	,, ,,
,,	Hanson	,,	404	120	Constantinople Passenger Service
,,	Elhem	,,	404	120	,, ,,
1874	Guernsey	Screw	645	150	South-Western Railway Company
,,	Calais	,,	378	80	London, Chatham, and Dover Railway Co.
,,	Brahestad	Paddle	229	40	Finnish Coasting Trade
,,	Guarany	,,	146	80	Brazilian Government
,,	South-Western	,,	800	180	London and South-Western Railway Co.
1875	Long Kat	Twin screw	322	60	Penang and Sumatra
,,	Independencia	,,	5055	1200	Brazilian Navy
,,	Duckenfield	Screw	446	60	New South Wales

been first successfully introduced by Messrs. Dudgeon. In the tabulated statement above we give the principal vessels built by their firm between the years 1861 and 1875, none being included under 100 tons of tonnage, many of which were also engined by them.

In addition to the vessels given in the above list, Messrs. Dudgeon built and engined a large number of tug steamers for the Thames and foreign service, stern-wheelers for Russia, torpedo launches for the Chilian navy, lightships for China, &c., making a total of 134 vessels before the works and shipyard were closed in 1875.

The torpedo having in the early "seventies" been so far perfected as to become a practicable instrument of warfare, it became necessary that high-speed boats should be provided for the purpose of utilising it against an enemy afloat. The first boat designed for the purpose in this country was, we believe, built by Messrs. J. I. Thornycroft and Co. in 1873, which, being found capable of effecting the purpose intended, was—after a similar vessels had been built by them for the Austrian, Danish, and French Governments—followed in 1877 by the Lightning, the first torpedo boat in the British Navy. This boat was 81ft. long by 10ft. 10in. beam, and was fitted with a pair of compound engines, the high-pressure authentic detailed record of their work; all trace of their members either having been lost or, if found, their diffidence in the matter precluding our getting the desired information.

In concluding our brief record of the progress of shipbuilding and marine engineering on the Thames during the last sixty years, given in the series of articles before referred to, and to which the foregoing is an appendix, we have to acknowledge with unfeigned pleasure the courtesy and kind help which have been accorded us by the representatives of those firms whose work during the time covered by our articles has come under notice. Especially are we indebted for the assistance so unreservedly given in supplying us with information and the means of illustrating our subject, to enable us to place it adequately before our readers. On the causes which have led to the decline of shipbuilding on the Thames we have refrained from commenting, the subject being one outside the intention of our record.

Instructions have been issued for a detachment of Royal Engineers to be made ready at once for service in Egypt and the Soudan. On arrival in Egypt the detachment will be told off for duty in connection with a scheme for developing the telegraph system in the Soudan.

A NEW RUSSIAN BATTLESHIP.

Of Russian battleships building, the craft for which the keel has just been laid at the shipyard of Messrs. Cramp and Co., Philadelphia, U.S.A., is in some important particulars the most powerful, and when finished will give that nation a fighting machine of highly efficient order. This battleship, for which the name has not yet been chosen, may really be described as a Russianised version of the Maine, Missouri, and Ohio, recently authorised by the United States. The principal dimensions and general particulars are:—Length between perpendiculars, 376ft.; breadth, extreme, 72ft. 2·5in.; draught, not to exceed 26ft.; displacement, about 12,700 tons; indicated horse-power, estimated, 16,000; speed, at full displacement, for twelve hours, 18 knots; complement, about 750.

The armament will consist of four 12in. breech-loading rifles, twelve 6in. breech-loading rapid-firing rifles, twenty 3in. rapid-firing rifles, two 2½in. rapid-firing rifles, twenty 47mm. rapid-firers, six 37 mm. rapid-firers, six torpedo tubes. The hull is of steel, unsheathed, and supplemented by the usual inner bottom, extending fore and aft throughout the greater part of the vessel and reaching up to the armour shelf at the bottom of the water line belt. This inner-bottom space may be used in part for liquid fuel, and provision is also to be made for the carriage there of feed-water if needful. The hull is protected from attack, first, by a 7½ft. water-line belt extending from abreast the after barbette forward to the stem. At normal draught 4ft. of the belt below water. This belt is 9in. thick, and for two-thirds its total length maintains its maximum thickness. Forward of the maximum thickness the belt gradually tapers to 2in. at the stem.

Above the water-line armour, and up to the line of the first gun deck, the sides are reinforced by a continuous band of 6in. armour. The ledge of this plating is distinctly shown in the illustration on page 644. The gun casemates are 5in. thick about the guns of the midship batteries on both decks. The protective deck extends from bow to stern. In wake of the heaviest portion of the water-line belt the slopes of this deck, which terminate against the lower edge of the water-line armour, are 3in. thick, while the flat is 2in. thick. Forward and abaft this region the slopes are increased to 4in., the midship flat section remaining still 2in. Following the line of the ends of the superstructure, diagonal athwartship bulkheads of 9in. steel extend from the protective deck to the gun deck, and from the gun deck to the main deck, completely blocking a raking fire. All of the armour will be treated by the Krupp process. Coal, of course, is stowed in the wake of the water-line armour and on top of the protective deck, affording just that much more protection against shot or shell.

The four 12in. guns, which will be of forty calibres, will be mounted in two turrets, one forward and one aft of the central superstructure and on the same deck. At present the design of the turret is of the Russian type, but there is every probability that the turrets will eventually be similar to those for the Maine and her sister ships. At present the turrets and barbettes shown have a continuous thickness of 10in., and the guns have an arc of fire of quite 340 degrees. The 6in. guns, which will be of forty-five calibres, are to be mounted on the gun and the main deck. Eight, four in each midship battery, will be placed amidships on the gun deck. These guns are placed in rectangular sponsons, and have each an arc of fire of 120 degrees. Heavy cylindrical shields are placed on the guns. The four remaining 6in. guns are mounted on the main deck at the corners of the superstructure, where their arcs of fire are about 180 degrees. The 3in. guns are mounted, twelve on the gun deck forward and abaft the 6in. battery, six on the main deck between the 6in. batteries again, and two, one on each side, amidships, upon the bridge deck. The rest of the small guns are placed forward and aft on the bridges, the bridge deck, and up in the tops. The six torpedo tubes are disposed one at the bow, one at the stern, and four, two on each side, amidships. The broadside tubes, so it is said, are to be of the under-water type.

Elaborate arrangements provide for a continuous supply of ammunition to the rapid-fire guns. The turrets, all ammunition hoists, and many of the auxiliary machines will be operated by electricity. In the matters of comfort and convenience for the complement the ship will be typically American. There will be a very extensive drainage and ventilation outfit. The ship will be driven by two triple-expansion engines, in separate water-tight compartments, actuating twin screws. They will be of the three-cylinder type, and the diameters, respectively, for the high, intermediate and low-pressure cylinders, will be 38½in., 59in., and 92in., with a common stroke of 42in. The collective indicated horse-power of the engines for the air and the circulating pump engines, and for the main engines, when the latter are making something like 126 revolutions a minute, will be 16,000. This is to be kept up continuously for a trial of twelve hours, and that under natural draught. The high-pressure cylinders are forward, and the low-pressure cylinders aft. The main valves will be of the piston type, worked by Stevenson link motions with double bar links. The valve gear of these cylinders will be made interchangeable as far as possible. There will be one piston valve for each high-pressure cylinder, and two for each intermediate-pressure cylinder; each low-pressure cylinder will have four piston valves. The crank shafts will be made in three sections and interchangeable. The cranks will be 120 degrees apart. All crank, line and propeller shafting will be hollow. Each main condenser will have a cooling surface of about 9600 square feet, measured on the outside of the tubes, the water passing through the tubes. Each engine-room will have an auxiliary condenser, having not less than 800 square feet of cooling surface.

Steam will be supplied by twenty-four water-tube boilers of the Niclausse type, constructed for a working pressure of 250 lb. per square inch, reduced to 200 lb. at the high-pressure cylinders. The boilers will be placed in four water-tight compartments, and there will be two double and two single-ended fire-rooms. The total amount of heating surface will be about 58,104 square feet, and the total grate surface will be about 1353 square feet. There will be twenty-four furnaces, with seventy-two fire and ashpit doors, fitted with the latest and best designs of the Messrs. Niclausse. The boilers are to be of iron, malleable iron, cast iron, and steel. Ordinary cast iron will not be employed in parts subject to steam pressure. Pipe fittings and cocks will be of bronze. The steam drums will be made of mild steel of ample thickness for a working pressure of 256 lb., and will be fitted with plates for receiving the collectors or headers, which will be of malleable iron thoroughly annealed, and subject to a hydraulic pressure of 400 lb. per square inch before being incorporated into the

boilers. The boiler casings will be complete in sheet steel and angle bars, with coverings of magnesia or some other approved non-conducting material. They will be fitted with grate supports, ashpits, doors for sweeping tubes, balance fire doors closing automatically, balance ashpit doors, and all similar approved features. The chimneys, of which there will be three, will reach to a height of 100ft. above the grate bars.

The full coal supply will be 2000 tons. The ship will be lighted throughout by electricity, and will carry six large search lights, four of which will be placed upon the bridges, and two others up in the tops of the military masts. The ship imposes some exacting conditions upon the builders, but there is no fear of successful fulfilment on their part. The batteries will be furnished by Russia, and it is likely the guns will be of French manufacture to a large extent. The contract price is not known. The ship will carry two second-class torpedo boats.

DOCKYARD NOTES.

IF M. Lockroy has done nothing else, he has certainly left his mark upon the French navy, so far as appearances go; there is hardly a ship that has not been altered, or else ordered to be altered. Thus the familiar Hoche will emerge from her "transformation" with the superstructure gone and two funnels instead of one. The Magenta is to lose her superstructure. The Tonnant has been quite altered in appearance, the Sfax, Richelieu, Colbert, and Trident have each lost a mast; the absurd fighting top around the funnel has been removed from the Redoutable. The Dévastation will soon be about in quite another rig; the Indomptable class is changing completely. Even the new Massena appears not to have escaped the reformer's hand. Speaking generally, all these changes are advantageous, being designed in each case to increase the stability of the ships treated.

TALKING of changes in ships' appearances, towards the end of 1897 the American New York had some of the tops taken off the main mast, and she, of course, had this rig in the war. In the light of this fact, it is somewhat interesting to look up the sketches and photographs of "our special artists" during the late war.

A REPORT has been current for some while to the effect that 6in. quick-firers are to be substituted for the 4·7in. in the Gladiator. The 4·7's are, however, still in position on board the cruiser. If the change can be effected without affecting other qualities, there is no question as to the improvement of offensive power. A single 6in. is probably worth a couple of 4·7in. The small piece does not fire appreciably much faster—not, at least, in actual practice—and its shell is only 40 lb. against the 100 lb. of the 6in. projectile. The one large shell would probably do more harm morally, if not actually, than three of the 40 lb. size.

As regard the rate-of-fire question, some officers put it against the single-action 6in. quick-firers that they fire too fast, even for a ship carrying two hundred rounds per gun. They argue that a tremendous amount of control will be necessary, and control is relatively more difficult with the isolated casemate system than with the old-fashioned battery. How some of the foreigners, with, perhaps, only fifty rounds per gun, propose to deal with the question we do not know, but there is certainly the possibility of using up all the ammunition before the crisis of the battle. The new German ironclad Kaiser Friedrich der Dritte is a case in point. She carries four heavy 9·4in., eighteen 6in. quick-firers, and a number of 20-pounder quick-firers, all of which would presumably be used in action. We believe that the Krupp system does not lend itself to very rapid rates of fire so much as some others; but, even so, the ship is only of 11,000 tons and heavily armoured. Her broadside—theoretically, at any rate—must be simply appalling, but for how many minutes will she be able to fire?

A GOOD deal has been said about the Pelorus and Arrogant having to be towed home from Gibraltar because they had run out of coal. In one or both cases lack of coal was not the cause, but tubes choked through these ships having to use up the fag ends of "Admiralty mixture" consequent upon the recent strike.

THE Canopus has now been launched fourteen and a-half months. She has some guns on board and her masts up, but no funnels, nor are her sides complete. The extraordinary delay may be attributed to a number of causes; but, all things considered, it is just as well that the Admiralty have stopped the making of dockyard "records." The Glory and Vengeance are to come to Portsmouth for completion; the odds are that they will be in commission as soon as the Canopus at present rates.

YORKSHIRE COLLEGE ENGINEERING SOCIETY.—The fifth ordinary meeting of the session of the Yorkshire College Engineering Society was held in the Lecture-room at the College on Monday 19th, when a paper was read on "Premiums Paid to Experience," by Mr. Henry McLaren, M.I.M.E. Mr. McLaren emphasised the necessity of practical experience, and premiums paid to experience. After having a college training, practical experience was very necessary before a pupil became competent to design special machinery. Practical experience was also necessary for those who intended to become commercial travellers in machinery, for if they had a thorough working knowledge they would explain the merit of their goods better. Mr. J. H. Wicksteed, president of the Society, occupied the chair. He showed a lot of lantern slides of the country of New Zealand, where a number of their road locomotives are working, illustrating the difficulties they have to encounter.

NEWPORT, ISLE OF WIGHT, WATER SUPPLY.—The formal inauguration of the new water supply of Newport, Isle of Wight, took place on Wednesday, the 21st inst. The supply, which amounts to 1,200,000 gallons in ordinary weather, and did not fall below 800,000 gallons a day in the height of the drought of this year, is derived from the Bowcombe Valley, just above Idlecombe, a distance of some 2¼ miles from the existing pumping station at Carisbrooke. Contamination of the existing wells was the immediate cause of these new works being undertaken. The new source of supply is from a practically uninhabited area, and the water is obtained from the chalk at a depth of some 60ft. to 70ft. Great difficulties have had to be overcome by the contractor, Mr. Henry Hill, of Maidenhead, owing to the amount of water and soft slippery ground met with. Part of the town of Newport will be supplied from this new source direct by gravitation, a "head" of some 70ft. being obtainable. The remainder of the town will be supplied as heretofore from the existing pumping station, but with the water from the new source. These works, which have entailed an expenditure of nearly £20,000, have been carried out to the designs and under the direction of Mr. Baldwin Latham.

TORPEDO VESSELS BUILT ON THE THAMES

Principal Vessels Built and Engined by Messrs. J. I. Thornycroft and Co., 1877 to 1898.

Date of building.	No. of vessels	Government built for.	Type of vessel.	Dimensions. Length.	Dimensions. Beam.	Number and type of boiler.	I.H.P.	Speed on trial.	Some typical ships.
				ft. in.	ft. in.			knots.	
1877	1	British	T.B.	81 0	10 10	1 locomotive	460	18	H.M.S. Lightning
,,	1	Dutch	,,	75 0	10 0	1 ,,	350	18	
1878	9	French	,,	87 0	10 6	1 ,,	450	18	
,,	1	Italian	,,	76 0	10 0	1 ,,	350	18	Veloce
,,	1	Austrian	,,	87 0	10 6	1 ,,	450	18	
,,	2	British	,,	87 0	10 6	1 ,,	450	20	
,,	6	,, ...	,,	59 0	7 6	1 ,,	100	15	
1879	3	French	,,	87 0	10 6	1 ,,	420	18	
,,	6	British	,,	87 0	10 6	1 ,,	450	20	
,,	6	,, ...	,,	59 0	7 6	1 ,,	100	15	
,,	6	Dutch	,,	76 0	10 0	1 ,,	350	18	
,,	2	French	,,	59 0	7 6	1 ,,	150	16	
,,	1	Danish	,,	94 0	10 6	1 ,,	450	21·32	
1880	5	British	,,	60 4	7 6	1 ,,	150	17·64	
,,	1	Russian	,,	60 4	7 6	1 ,,	150	16·84	
,,	3	British	,,	87 0	10 6	1 ,,	450	20	
1881	5	,, ...	,,	60 4	7 6	1 ,,	150	17	
,,	2	Argentine	,,	60 4	7 6	1 ,,	150	17	
,,	2	French	,,	60 4	7 6	1 ,,	150	17	
,,	2	Italian	,,	92 0	10 6	1 ,,	475	21·8	
,,	1	Danish	,,	110 0	12 4	1 ,,	700	20·76	Sverdfisken
1882	7	British	,,	60 4	7 6	1 ,,	150	17	
,,	10	Italian	,,	100 0	12 0	1 ,,	450	·21	Aldebaran Class
,,	2	Danish	,,	63 0	7 6	1 ,,	150	17	
,,	1	Swedish	,,	100 0	12 0	1 ,,	500	20·75	
1883	12	British	,,	60 4	7 6	1 ,,	150	17	
,,	2	,, ...	,,	60 4	7 6	1 water-tube	150	17	
,,	14	Italian	,,	63 0	7 6	1 locomotive	170	17	Euterpe Class
,,	1	Russian	,,	113 0	12 6	1 ,,	680	19·5	Sookhoum
,,	1	Victorian	,,	113 0	12 6	1 ,,	680	19·1	H.M.S. Childers
,,	4	Italian	,,	66 0	8 0	1 ,,	290	19·28	Mosca Class
,,	1	Danish	,,	111 6	12 6	1 ,,	700	20	Delfinen
1884	4	New Zealand	,,	63 0	7 6	1 ,,	170	17·5	
,,	3	Victorian	,,	63 0	7 6	1 ,,	170	17·5	
,,	1	Queensland	,,	63 0	7 6	1 ,,	160	17	
,,	1	German	,,	63 0	8 0	1 ,,	160	15·5	
,,	1	Swedish	,,	113 0	12 6	1 ,,	630	19·15	Hugin
,,	1	German	,,	117 8	12 6	1 ,,	671	19·34	
,,	1	Danish	,,	114 0	12 6	1 ,,	675	18·71	Hvalrossen
,,	2	,, ...	,,	66 9	8 0	1 ,,	169	15·32	
1885	2	British	,,	113 0	12 6	1 ,,	732	19·97	
,,	2	Spanish	,,	117 8	12 6	1 ,,	618	20·23	Julian Ordonez and Acevedo
,,	1	British	,,	125 0	12 6	1 ,,	590	19·38	
1886	2	,, ...	,,	63 0	8 0	1 water-tube	189	16·8	
,,	22	,, ...	,,	125 0	12 6	1 locomotive	770	21·66	
,,	2	Danish	,,	68 3	8 0	1 ,,	180	15·72	
1887	2	British	,,	125 0	12 6	1 ,,	770	21·5	
,,	1	Spanish	,,	127 6	12 6	1 ,,	780	21·32	
,,	2	,, ...	,,	147 6	14 6	2 water-tube	1650	26	Ariete and Rayo
,,	2	Danish	,,	129 0	14 9	2 ,,	1300	23·29	Stören and Solöven
1888	2	,, ...	,,	137 0	14 9	2 ,,	1275	22·89	Narvahlen and Havhesten
,,	1	French	,,	147 6	14 6	2 ,,	1500	23·5	Coureur
,,	3	Indian	,,	128 6	14 9	2 ,,	1270	23·25	
,,	2	Danish	,,	68 3	8 6	1 ,,	190	15·75	
1889	2	,, ...	,,	80 0	9 0	1 ,,	382	17·96	
1890	2	Argentine	,,	150 0	14 6	2 ,,	1860	25	Murature and Commodoro Py
1891	3	Brazilian	,,	150 0	14 6	2 ,,	1960	25·86	
1893	1	British	T.G.	230 0	27 0	8 ,,	4700	20·55	H.M.S. Speedy
1894	2	,, ...	T.B.D.	185 0	19 0	3 ,,	4640	28·21	H.M.S. Daring and Decoy
,,	3	,, ...	T.B.	140 0	15 6	2 ,,	2357	24·52	
1895	3	,, ...	T.B.D.	200 0	19 0	3 ,,	4543	29·17	H.M.S. Ardent, Boxer, and Bruiser
,,	6	,, ...	,,	210 0	19 6	3 ,,	5800	30·43	H.M.S. Desperate, Foam, &c.
1896	3	,, ...	,,	210 0	19 6	3 ,,	not completed		H.M.S. Coquette, Cygnet, &c.
,,	1	,, ...	,,	227 0	21 3	4 ,,	not completed		H.M.S. Albatross
,,	1	German		211 9	19 6	3 ,,	5800	28·54	D10
1897	4	Japanese	,,	210 0	19 6	3 ,,	not completed		Murakumo Cy
,,	1	British	,,	210 0	19 6	3 ,,	not completed		H.M.S. Stag
1898	2	Japanese	,,	210 0	19 6	3 ,,	not completed		

Principal Vessels Built and Engined by Messrs. Yarrow and Co., 1877 to 1898.

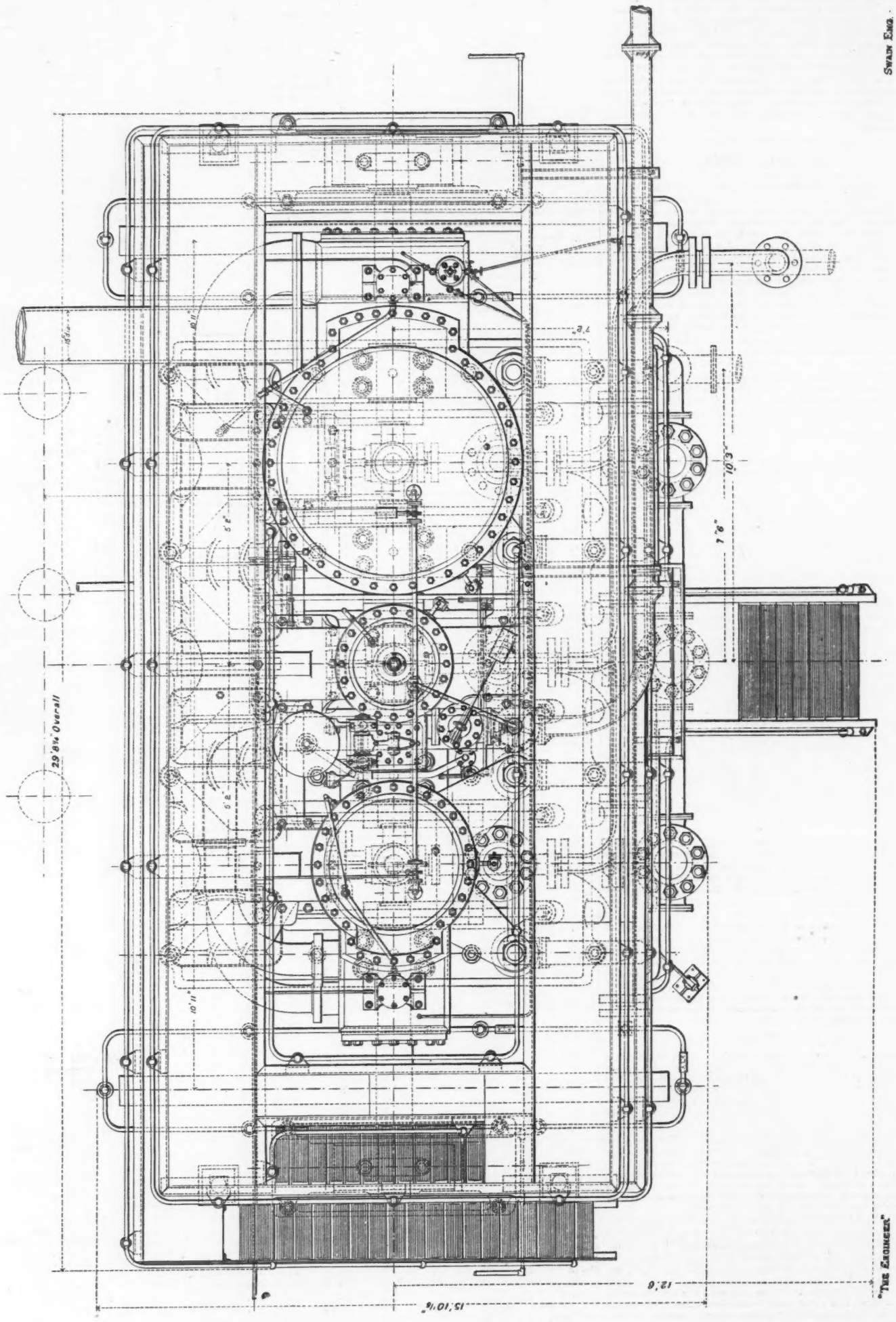
Date of building.	No. of vessels	Government built for.	Type of vessel.	Dimensions. Length.	Dimensions. Beam.	Number and type of boiler.	I.H.P.	Speed on trial.	Some typical ships.
				ft. in.	ft. in.			knots.	
1877	2	British	T.B.	86 0	11 0	1 locomotive	420	20·75	
1878	2	French	,,	86 0	10 10	1 ,,	—	—	
,,	1	Spanish	,,	86 0	10 10	1 ,,	—	—	
,,	2	Austrian	,,	86 0	10 10	1 ,,	—	—	
1879	1	British	,,	86 0	11 0	1 ,,	420	21·94	
,,	2	,, ...	,,	62 0	7 6	1 ,,	150	16	
,,	2	Italian	,,	86 0	10 10	1 ,,	—	—	
,,	5	Russian	,,	100 0	10 10	1 ,,	—	—	
1880	2	British	,,	62 0	7 6	1 ,,	150	16·17	
,,	2	Argentine	,,	100 0	12 6	1 ,,	—	20	
,,	8	Chilian	,,	100 0	12 6	1 ,,	—	—	
,,	2	Austrian	,,	100 0	12 6	1 ,,	—	—	
1881	2	Dutch	,,	100 0	12 6	1 ,,	—	22·5	Etna and Hecla
,,	2	Portuguese	,,	100 0	12 6	1 ,,	500	21	
,,	2	Italian	,,	100 0	12 6	1 ,,	550	22·5	
,,	2	Brazilian	,,	100 0	12 6	1 ,,	500	21	
,,	2	Argentine	,,	100 0	12 6	1 ,,	500	20	
1882	4	Brazilian	,,	110 0	12 6	1 ,,	600	20·5	
1884	2	British	,,	113 0	12 6	1 ,,	750	19	
,,	2	,, ...	S.W.	75 0	18 0	1 ,,	—	—	H.M.S. Lotus and Waterlily
1885	23	,, ...	T.B.	125 0	13 6	1 ,,	700	19·5	
,,	1	,, ...	,,	129 0	13 6	1 ,,	1000	22·4	
,,	2	,, ...	S.W.	120 0	23 0	2 ,,	—	—	H.M.S. America and Sabia
,,	6	,, ...	,,	80 0	18 0	1 ,,	—	—	
,,	2	Austrian	T.B.	135 0	14 0	1 ,,	1200	24	Falke and Adler
,,	1	Japanese	,,	166 0	19 6	2 ,,	—	19	Kotaki (Twin Screw)
1886	1	British	,,	135 0	14 0	1 ,,	1500	23	No. 80
,,	2	Italian	,,	140 0	14 0	2 ,,	1600	25	
,,	2	Spanish	,,	135 0	14 0	1 ,,	1600	24	Azor and Halcon
1887	1	British	,,	60 0	8 6	1 ,,	220	17	
,,	1	,, ...	,,	56 0	8 3	1 ,,	200	16	
1888	6	,, ...	,,	130 0	13 6	1 ,,	1130	22·5	
1889	10	,, ...	,,	60 0	9 3	1 ,,	230	16	
,,	6	Argentine	,,	130 0	13 6	1 ,,	1200	24	
1890	2	British	S.W.	77 0	18 0	1 ,,	86	10	H.M.S. Mosquito and Herald
1892	1	,, ...	T.B.D.	180 0	18 6	2 ,,	3500	26·1	H.M.S. Havock
,,	1	,, ...	,,	180 0	18 6	8 water-tube	3884	27·6	H.M.S. Hornet
,,	2	,, ...	T.B.	142 6	14 9	1 locomotive	1600	24	
1894	3	,, ...	T.B.D.	190 0	18 6	2 ,,	3200	23	H.M.S. Charger, Dasher, and Hasty
,,	1	French	T.B.	60 0	9 3	1 water-tube	270	20·5	
1895	2	British	,,	142 0	14 6	1 ,,	1600	23·1	
,,	1	Russian	,,	190 0	18 6	8 ,,	3800	29·75	Sokol
,,	1	Austrian	,,	147 6	14 9	2 ,,	2000	23·6	Viper
1893	4	Argentine	,,	190 0	19 6	6 ,,	4000	27	Santa Fé, Entre Rios, &c.
,,	6	Chilian	,,	152 6	15 3	2 ,,	2000	27	
1897	6	British ... ... }	Raised	100 0	20 0	1 ,,	250	10·5	Heron Class
,,	2	Egyptian ... ... }	screws	145 0	25 6	2 ,,	450	13	Sultan and Sheikh
1898	2	Austrian	T.B.	152 6	15 3	2 ,,	2000	24	Cobra and Boa
,,	1	Japanese	T.B.D.	220 0	20 6	4 ,,	6000	31	Ikadsuchi

T.B. torpedo boat; T.G. torpedo gunboat; T.B.D. torpedo boat destroyer; S.W. stern-wheeler.

HYDRAULIC PUMPING ENGINE

MESSRS. EASTON, ANDERSON, AND GOOLDEN, LIMITED, ERITH, ENGINEERS

(For description see page 641)



HYDRAULIC PUMPING ENGINE

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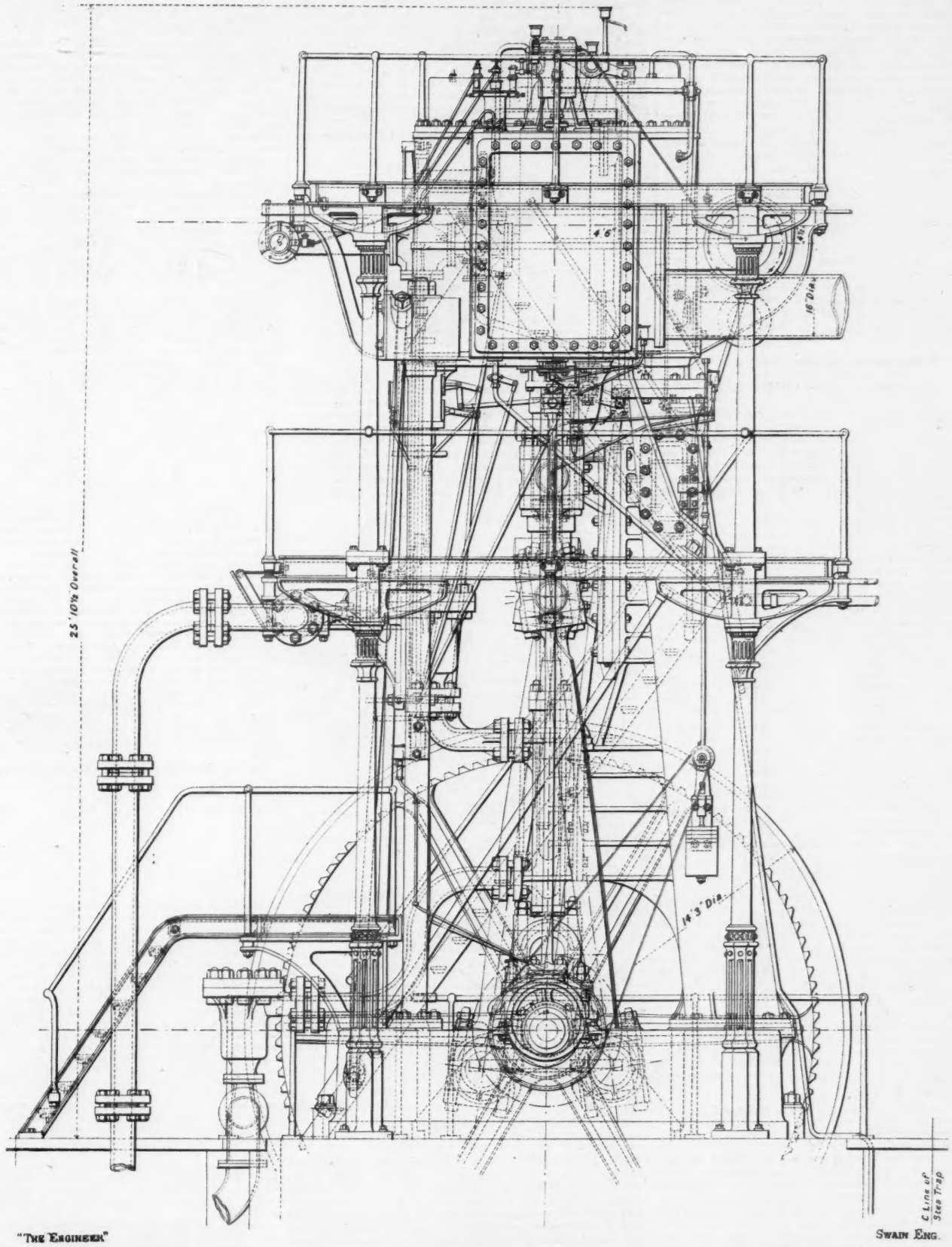


"THE ENGINEER" SWAIN ENG.

A LARGE HYDRAULIC PUMPING ENGINE.

IN our issue of October 21st last we gave a general view and particulars of a set of triple-expansion pumping engines which were made for the Tasmanian Gold Mining Company by Messrs. Easton, Anderson, and Goolden, Limited, Erith. We are now enabled to place before our readers a view representing an end elevation of these remarkably large hydraulic engines, which are of the triple-expansion inverted cylinder type, having cylinders 25in., 40in., and 69in. diameter by 42in. stroke. It will be seen that the pumps are placed directly below the crossheads and in line with the piston rods. The high-pressure cylinder is fitted with a piston valve and internal expansion valve; the intermediate-pressure cylinder has a flat side valve, having an expansion valve on the back: and the low-pressure cylinder has a double-ported slide valve. Balance cylinders are provided on the top to support the valves, so as to minimise the stresses on the excentric rods. Steam at 170 lb. pressure is used in the high-pressure cylinder. Further particulars will be found in our issue of the above date. The use of machinery of this type seems to be increasing, and with good reason, for the loss by transmission is very moderate, when the machinery is properly designed.

H.M.S. DIADEM.

WE publish this week a concluding series of engravings of the Diadem, representing the profile and deck plans of this first-class cruiser, taken from drawings kindly furnished by the Fairfield Shipbuilding and Engineering Company, of Govan, Glasgow. It is seldom that such a complete series of sketches has been obtainable of any recent British war vessel, and the particulars supplied are, consequently, valuable. We are enabled by them slightly to modify, in one or two instances, remarks which we made in our first paper upon the Diadem, in THE ENGINEER of October 28th. The drawings, which were prepared upon a scale of $\frac{1}{16}$in. to the foot, have necessarily been reduced for reproduction, but the proportions are exact; hence these engravings are most instructive.

One feature which will attract attention is the large extent of armoured protection afforded. The protective deck, of 4in. steel over the greater part of its length, stretches from 6ft. below the water-line on either side to 3ft. 6in. above it at the centre line of the ship; and further rises 18in. higher in the way of the engine-room, so that at this spot a vertical depth of no less than 11ft. is defended from medium shell fire. Whether such armoured protection would not be more effectual on the outside of the ship, instead of the inside, is a moot point. The casemates for the 6in. quick-firing guns, cover each of them a space 20ft. wide, covered with 6in. Harveyised steel. But it certainly does look as though the intervals between them would be at the mercy of gun fire, even from weapons of small calibre. There is a cofferdam above the armoured deck around the coamings over the engine and boiler-room hatches, which it is proposed, we understand, to fill as well as the cofferdams, around the hatchways leading below, with spare chains and such like materials. These would in action arrest the progress of projectiles passing through the vessel, but would not prevent their coming in. Indeed, the principal object appears to be that of preventing water from flowing down beneath the armoured deck. Nevertheless, there is little doubt that the whole of this cruiser's vitals, such as engine and boiler spaces, magazines, torpedo and dynamo rooms, together with the steering gear and ammunition passages, are marvellously well shielded from the direct and after effects of ordinary shell fire by the ample protective deck, and that the between deck 6in. gun positions could not be more securely screened from bursting shell. The shapes and substance of casemates are accurately shown.

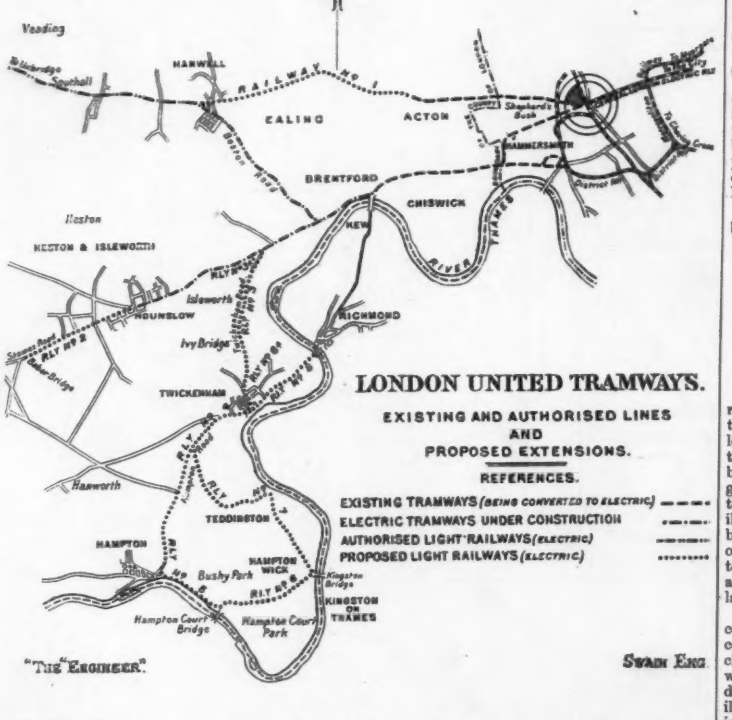
The height of the gun positions on the forecastle platform is very striking. Their axis is, in each case, 34ft. above the

load water-line, and this gives a clear height of 2ft. above the point of the stem. The command of the 6in. guns aft is only 22ft., as the highest point on the quarter deck—which has a slight sheer towards the stern—is only 18ft. But this even is far superior to the command on many of the older cruisers, and, as we observed in our first paper upon the Diadem, the forward guns are of infinitely greater importance than those mounted upon the quarter deck. The mounting of these guns on platforms, so as to be clear of water washing over the decks, is admirable. The position of the three 3-pounder Hotchkiss and Maxim guns is not shown in the engravings, as the former are only boat guns, with alternative mountings upon the vessel's superstructure, and the Maxims are only carried on their pedestals on the boat deck sides when required for actual use.

The double-bottom of the Diadem is of great extent, as may be seen by a reference to the profile engraved. It is rather more than 290ft. from bulkhead to bulkhead forward and aft, and beyond these spots it is practically carried almost up to the stem and stern by water-tight flats. When we compare this arrangement with that obtaining in the earlier cruisers, where the boiler and engine-room space was comparatively short, and the bracket framing ended at the extremities of this short length, the parts beyond each way being only water-tight so long as the skin was intact, the improved character of the Diadem, as regards buoyancy, will be at once realised. It should, indeed, be very difficult to sink this vessel at all, unless by wreck or ramming. The ventilating trunks, which must, of course, pass through important bulkheads, are all fitted with automatic doors at these points, and the flooding of the compartment in which they are situated shuts them at once, so as to isolate that section from the rest of the ship.

ELECTRIC TRAMWAYS AND LIGHT RAILWAYS.

THE accompanying sketch map shows the strides which electric traction is now making or is about to make in the West of London. The lines indicated as being proposed and under construction or conversion are those which form part of the system of the London United Tramways Company, which in the beginning part of this year obtained powers to substitute electric traction for horse haulage on its existing tramways in Acton and Chiswick, and to lay new electric tramways from Kew Bridge through Brentford to Hounslow, and from Brentford to Hanwell. Further, the company has received permission from the Light Railway Commissioners to construct an electric tramway between Uxbridge and Hanwell. In its last year's Bill the company sought powers to connect Acton and Hanwell by an electric tramway, but, owing to opposition on the part of Ealing, this portion of the Bill was struck out. This session, however, the company is again seeking increased powers, and the Acton and Hanwell branch again occupies a place in its Bill.



Ealing is very largely a residential district. There is a considerable proportion of wealthy inhabitants. The houses along the route to be taken by the trams are in many instances of high class, and doubtless it was from these that opposition came last year, and may be expected again. It is hardly likely, however, that such opposition will continue to prevail. Much as it is to be regretted from some points of view, we must march with the times, and Ealing will probably find this out. Increased means of communication with the City are greatly needed. The Great Western and the Metropolitan District Railways, together with the omnibuses at present at work, are inadequate, and the new tramway aims at supplementing, if not superseding, all of these for local traffic. There will be an almost straight run right from Uxbridge to Shepherd's Bush, where connection is to be made with the Central London Electric Railway now under construction, and it has been stated that the rate of travelling on the trams will be quite as quick and much cheaper than on any existing route. The company proposes to lay a double line of rails all the way, and to provide and maintain wood paving of not less than 17ft. wide. Further, it intends to use the overhead trolley system, and to run a five-minutes' service in each direction, charging one halfpenny per mile for fares. As we have already said, Ealing, or a part of it, will again oppose this scheme, but this time it seems to be not improbable that a portion, at all events, of the ratepayers of the district, perhaps a large portion, will support the Tramway Company in its application, for there is a growing demand for conveyance at a quick rate, not only between Ealing and the City, but between the various localities *en route*.

The tramway through Ealing is only one of a number for which powers are now sought by the company. As will be seen from a glance at the sketch map, it is proposed to extend the Brentford-Hounslow lines to Baber Bridge, and to run a branch from between Brentford and Hounslow to Twickenham, and to lay lines from Richmond Bridge to Twickenham, and thence, by means of a loop embracing Hampton, Hampton Court, between Bushey Park and Hampton Court Park, to Kingston Bridge and Teddington.

Should this Bill obtain the sanction of Parliament, it will mean an addition of over 16½ miles of tramway in this district, the whole of which will be worked electrically, and locomotion thereby considerably facilitated.

IMPROVEMENTS IN CYCLE CONSTRUCTION.

SOME very useful improvements in cycle construction and gear are being introduced by Mr. George Thornhill, of West Didsbury, Manchester. Amongst these is a new patent direct-action chainless driving gear, which consists of an intermediate wheel, provided with roller teeth, or a ½in. pitch roller chain fitted and placed round the wheel, the rollers then becoming roller teeth. This wheel comes between and connects the driving wheel on the axle and that on the back wheel of the cycle, and works loose on double-coned ball bearings, with a width of boss of about 1¼in. By this means a direct connection is obtained between the axle and the back wheel of the cycle, and instead of being pulled it is now lowered, whilst the power is transmitted with a minimum of friction. Another of Mr. Thornhill's inventions is a patent detachable axle cylinder, designed to overcome the

difficulty frequently encountered in setting the axle square again with the frame when worn through continued pulling by the chain. This arrangement consists of a new bottom bracket, and, as already stated, a detachable axle cylinder, the construction being clearly shown in the accompanying illustration. In cycles as at present constructed, the axle cylinder is part and parcel of the fixed frame, and when once made is practically unalterable, so that it can neither be adjusted nor renewed when worn or cracked, or the metal is discovered to be defective, the whole frame in such cases being rendered practically useless. By this new arrangement, however, it is in such cases only necessary to take off the cylinder, the cycle being in this respect similar to an ordinary engine, in which the workings and the bed are detachable. The most vital and important part of the cycle can thus be readily removed for adjustment or renewal, the frame being left intact, whilst the arrangement also obviates the trouble of carrying the whole machine if anything requires attention.

THE *Pester Lloyd* has received from what it describes as a trustworthy source the following interesting particulars respecting the new French quick-firing gun. The introduction of this arm has made such rapid progress for several months past that in all probability over 480 batteries of the field artillery will be fully equipped with it during the coming spring. In round numbers this will require 3000 quick-firing guns, 4500 ammunition carts, and 6000 other vehicles. At the beginning of the present year serious uneasiness was felt among French artillery officers at the advantage which the German field artillery was supposed to have secured through an improved description of ordnance. It turned out later on, however, that the German artillery still retained their old weapons, and that the adoption of the new system had probably not been sanctioned even in principle. In France, on the other hand, the preparations for the introduction of the new gun had been completed last spring. It was therefore possible to begin the manufacture of the guns at Bourges and Puteaux, the necessary ammunition being at the same time produced on a large scale. All that is known of the new quick-firing gun is that it has a calibre of 7·5 c., and is capable of discharging twenty shots a minute. The projectile, shrapnel, has a muzzle velocity of 600 m. The cartridge weighs 6·5 kilos. The recoil of the gun is greatly reduced by means of an ingenious contrivance.

INCANDESCENT GAS LIGHTING.

DURING the last decade a very remarkable development in the methods of utilising gas for lighting purposes has been taking place—a development which has resulted in producing a light of given intensity with less than one-fifth of the quantity of gas required by the common flat flame or argand burners, with a consequent diminution of the objectionable products of combustion—heat, carbon dioxide, and water vapour.

It has long been known that when certain substances are held in a non-luminous gas flame they will become incandescent, and emit a brilliant light without undergoing any perceptible chemical change; and attempts were early made to utilise metallic platinum, and the oxides of calcium and magnesium, for ordinary lighting purposes. The first Welsbach mantles, however, did not make their appearance until the year 1886, and they were then so fragile that their practical utility was not very great, nor did they yield so powerful a light as those of the present day. It may, in fact, be truly said that as recently as ten years ago incandescent gas lights were little more than scientific curiosities; whereas to-day they are used in every quarter of the globe, and number many hundreds of thousands.

The mantles now employed consist simply of oxides of certain metals, and are made by soaking a network hood of ordinary cotton in a solution of salts, which, when dried and ignited, will yield the oxides required. At the present time the Welsbach mantle is said to consist of about 98 per cent. of thoria and 2 per cent. of ceria, while formerly they consisted mainly of zirconia and lanthania. The salts usually employed are the nitrates, as these are soluble in water, and when dried and ignited yield oxides.

After the cotton hood has been soaked in the solution of salts it is passed through a wringer, dried, stretched into suitable shape, and ignited by means of a gas flame. The cotton now burns away, but leaves the metallic oxides—which were previously in solution as nitrates in the pores of the cotton mantle—in the form of the mantle. Finally, this mantle of oxides is heated over a blast flame to complete the conversion of the nitrates into the oxides, and then it is trimmed into shape and "collodionised." The object of dipping the mantle into a solution of collodion, or some substance of a similar nature, is to render it less liable to breakage when handled and during transport, and as soon as the mantle is placed upon the burner, and the flame is applied to it, the collodion burns away, and leaves the fragile network of oxides.

A remarkable fact concerning these mantles is that no pure oxide is known which will emit much light when heated in the ordinary manner, but that a second oxide, sometimes termed an "excitant," is always required. Thus, a mantle of pure thoria yields very little light, but if one per cent. of ceria is added to the thoria a brillant light is at once emitted, although a mantle of pure ceria also gives very little light. Several theories have been enunciated to account for this phenomenon, but none have yet been satisfactorily demonstrated to be correct.

Another noteworthy feature is that the colour of the light emitted by the mantle varies with its composition, and to a certain extent with the temperature to which it is heated. The two principal English incandescent gas light companies are those popularly known as the "Welsbach" Company and the "Sunlight" Company, and the thoria-ceria mantle sold by the former company emits a greenish-white light, while that of the latter, which consists of the oxides of aluminium and chromium, emits a golden-yellow colour.

Until quite recently a long glass chimney, to increase the air-draught around the burner, was a necessary adjunct to most of the incandescent gas light burners; but a new form of burner, known as the "Kern" burner, has been introduced, which, like the Bandsept burner, requires no chimney of any description, and which will yield an illuminating power of over twenty candles per cubic foot of gas consumed per hour with an ordinary gas pressure of, say, 1½in.

The following table shows the claims put forward for the new burner:—

No. of burner.	Gas consumption in cubic feet with 1in. pressure.	Approximate candle-power.
0	0½	20–22
1	1½	30–36
2	2	50–60
3	3	80–90
4	4	105–120
7	7	185–210

In practice, however, it is commonly found that a satisfactory result is not obtained with a pressure of less than 1½in., and that the illuminating values actually obtained are about 20 per cent. lower than those quoted in the table. As the pressure increases the consumption of the ungoverned burners, of course, also increases, but it is usually found that a much higher value per cubic foot of gas is obtained with a 2in. than with a 1in. pressure. But even these less favourable figures show so great an increase in the illuminating value of coal gas that the introduction of these new burners and mantles will, without doubt, give coal gas a new lease of life as a lighting agent and strengthen its claim to rank in towns where gas is as cheap as in London, as the poor man's light; although it is perhaps the suburban shopkeeper who will most largely avail himself of the recent improvements.

The incandescent electric light still remains the most cleanly, convenient, and pleasant form of artificial light, and will doubtless continue to increase in popular favour as it also is improved and cheapened; but in all towns where coal gas is cheap and water power unavailable, the incandescent gas light appears destined to take a leading place both as a public and a private illuminant; for even before the new burners were introduced the incandescent gas light was very largely used both for street lighting and for the illumination of shops and private residences, and when the expiration of patents allows uncontrolled competition in the manufacture and sale of burners and mantles, a substantial fall in prices may be expected, and an increased demand be anticipated.

There is still need for great improvement in the strength of the mantles and in the colour of the light emitted. It is true that the Sunlight mantle is less fragile, and produces a light that is less cold and less irritating to the eyes; but, as commonly exhibited in the shops, it is almost too yellow, and admits of considerable improvement. It does not, however, impart that ghastly pallor to human faces which is so noticeable in rooms illuminated with the thoria-ceria mantles.

In conclusion, mention may be made of those high-power incandescent gas lamps which have recently been introduced to compete with the electric arc lamps. In England the hydro-press and the Somzee-Grayson systems are high-power systems. The pressure of the gas supplied to the burners is increased by means of water power, and when this gas under high pressure is consumed in suitable burners, the mantles, which are specially made for these burners, emit a very powerful light. It is claimed for the hydro-press apparatus that a light of about 500-candle power may be obtained with a gas consumption of about 13 cubic feet per hour and a water consumption of 60 gallons per hour. It will, however, probably be found that the mantles are much more rapidly destroyed under this high-pressure system than by gas burning under the normal district pressure.

In calculating the cost of incandescent gaslight, allowance must, of course, be made for the initial cost of the burners and mantles, which, in the case of the high-pressure system, is very considerable, and also for the cost of new mantles; but it will be found that when these items have been included, the incandescent gaslight still compares very favourably with every other known form of artificial illumination in most towns supplied with coal gas at a cheap rate.—*The Builder*.

RAILWAY MATTERS.

THE Central London Railway Company is seeking, by means of a Bill which is coming before Parliament next session, for further time than is allowed by present statutory powers in which to complete the line from Shepherd's Bush to the City.

A NEW system of electric train lighting is now being experimented with on the Midland Railway. It has been devised by Mr. W. E. Langdon, the telegraph superintendent on this line. The current required for each vehicle is generated separately from one of the axles.

THE principal alteration in the train service of the London, Brighton, and South Coast Railway Company for next month is the acceleration of several evening trains from Brighton to London. It is arranged for the Sunday Pullman—limited—to and from Brighton to continue running to the end of March. The new fast Sunday train to and from Eastbourne will also continue to run.

ON Wednesday night Benjamin Dobson, sixty-eight, one of the North-Eastern Railway Company's oldest employés, and latterly traffic manager at Tebay Junction, was killed at Tebay Station. It is supposed that he was standing on the footboard of a moving train, and in attempting to alight he lost his balance and fell down the space between the station platform and the train. Several carriages passed over him, completely severing an arm and a leg from his body. He died shortly afterwards.

BUT for a timely discovery on Wednesday afternoon, a serious accident would in all probability have occurred on the Great Western Railway. A permanent way inspector, who was walking along the Oxford branch, between Culham and Radley stations, found one of the down metals broken. Information was immediately transmitted to Didcot Junction and elsewhere, and the traffic, unusually heavy, was worked on the up line, causing much delay and inconvenience to passengers, many of whom were returning from their Christmas holidays.

A SERIOUS landslip has taken place at Sasso Rosso, near Airolo, on the St. Gothard Railway, and as a result of the falls of earth, the Hotel D'Airolo has been entirely destroyed, together with several houses in the immediate vicinity. The inhabitants, fearing further falls, have deemed it advisable to leave the village. The railway station was damaged, but the line itself, which runs through the St. Gothard Tunnel, was in no way interfered with. Some of the telegraph wires were thrown down, but the necessary repairs can be speedily executed.

THE London and South-Western Company has a Bill before Parliament in which it is proposed, amongst other things, to widen and extend Waterloo Station, and in connection therewith to acquire certain lands and buildings. Among the proposals of Bill in this connection is one with a view to the discontinuance of the All Saints district as a separate district, and its annexation to the adjoining district or parish of St. John, Waterloo-road. The measure also includes provision for the widening of the company's Basingstoke and Salisbury line, but further capital powers proposed for this and other purposes are not to exceed £500,000.

TWELVE persons were injured on Saturday night by a level-crossing accident which occurred between Jarrow and Hebburn, two busy towns on the south side of the Tyne. The roadway between the two places passes over six level crossings, used in connection with neighbouring collieries and manufactories. On Saturday, when the vehicular traffic was very heavy, a conveyance containing fourteen persons left Hebburn for Jarrow, and as it was going over one of the level crossings a train of ten wagons dashed into the conveyance before the driver was aware of its approach. The engine smashed the vehicle, and threw the whole of its occupants into the road.

AFTER devoting a considerable amount of time to the investigation of the various systems of current transmission and of electrical apparatus, the Third Avenue Railroad Company, of New York, has decided to replace its cable traction by means of electricity, and has placed the work in the hands of the Westinghouse Electric Company. The power house will contain engines of the combined power of 64,000 horses, and will probably cost more than a million pounds sterling. It is interesting to note that the Niagara plant, up to now the most important power plant that has been constructed, developes 40,000-horse power, while the Third Avenue plant will be more than half as large, again. The same builders are now constructing an electric plant which will have an ultimate capacity of 75,000-horse power, driven by the waters of the St. Lawrence River. However, neither the Niagara nor the St. Lawrence plant is intended merely for railway, but chiefly for manufacturing and lighting purposes.

AN accident, which resulted in the injury of a Dover guard named Hoy, and damage to rolling stock, occurred at the South-Eastern Railway Station, Dover on Tuesday night. An empty train of carriages was being taken through the station, when, as the result of an error, an engine employed on shunting work was put upon the same line. Before the mistake could be rectified this engine had dashed into the rear portion of the train. The guard's van was considerably damaged, and its occupant sustained injuries which are stated to be severe. The force of the impact was lightened owing to the presence of mind of the driver of the engine, or the result might have been much worse. The facilities at the command of the South-Eastern Railway Company for shunting purposes are very limited at their Dover station, where the traffic has been greatly increasing for some years past; but in connection with the amalgamation which comes into force on January 1st, according to the *Times*, a scheme is now under the consideration of the railway companies and the Corporation of Dover, by which it is proposed to greatly improve the present conditions.

CONSIDERABLE developments are being made in the use of compressed air as a means of power transmission. For deep mine and tunnel work, where the exhaust is of value in renewing the fresh air supply, it is of especial value. Recent improvements in containing vessels, enabling very high pressures to be carried without a proportionate increase in the weight of the reservoirs, have made it practical for transportation purposes, and drays for merchandise, motor carriages, and street cars are already in use, and large railway locomotives immediately in sight. The large plant of the Rhode Island Locomotive Works has been acquired for the purpose of turning out this class of product, says our contemporary *Power*. One advantage that the system possesses over electricity is the sustained efficiency of the generating plant over wide variations of load. An engine connected to an electric generator has a maximum efficiency at a given rate of output, and decreases in efficiency as this rate is departed from in either direction, especially as the load is decreased. The air compressor, working into an accumulator against a constant pressure, can be run at practically the same load—that is, against the same resistance all the time—the varying demand for air being met by varying the speed of the engine, which can be done with much less interference with its efficiency than would result from the wide departure from its best ratio of expansion necessary to adapt the mean effective pressure directly to the varying load. The principal disadvantages revealed by its use so far have been the losses by leakage, and the tendency of the exhaust to choke up by freezing. The first of these is a mechanical difficulty, and with careful, intelligent piping, need not be excessive. The second may be obviated with an increase of efficiency on the part of the motor by pre-heating the air before it goes to the cylinder. This is said to introduce some difficulties in lubrication, which, however, should not be insurmountable, as the temperatures involved are not excessive.

NOTES AND MEMORANDA.

THE world's shipbuilding output for the year just closing is said to have been about 2,000,000 tons, of which the Scotch output has formed about one-fourth.

THE shipments of tin-plate from England to the United States for the month of November, 1898, amounted to 5238 tons of 2240 lb., an increase of 1478 tons over the exports of the preceding month, but a decrease of 524 tons below the average of the first ten months of this year. If the average for the eleven months of this year be maintained, a total export to the States of 63,000 to 64,000 tons for the year will probably be realised. The immense falling off in this trade is shown by the figures for the last five years, viz.: 1897, 85,575 tons; 1896, 113,051 tons; 1895, 222,901 tons; and 1896, 226,829 tons.

SOME figures relative to the cost of electric cooking were given in a paper on "The Practical Applications of Electrical Power," read by Mr. H. R. J. Burstall before the Royal Institution of British Architects last week. The following table was compiled by Mr. C. O. Grimshaw, of the Westminster Company:—

Cost of Running Cooking Apparatus at 4d. per Unit.

Description.	Capacity.	Cost per hour.	Cost of one operation from all cold.
Kettle	1½ pints	1·28d.	0·45d.
Griller	2 chops	2·24d.	0·53d.
Saucepan	2 quarts	1·6d.	0·8d.
Fish kettle	16 quarts	4·56d.	—
Domestic iron	Scorching paper	0·8d.	Cost to heat up, 0·12d.

THE height of buildings in the city of Washington is again under consideration, and the District Commissioners have submitted to the two District Committees of Congress a substitute Bill on the subject. This Bill restricts the height of non-fireproof residence buildings to 60ft., or five storeys, but allows a height of 75ft. for non-fireproof business buildings. All buildings except churches hereafter erected or altered to exceed 75ft. in height are required to be fireproof, and churches must be of fireproof construction up to and including the main or auditorium floor. No building may exceed in height above the sidewalk the width of the street in front, nor exceed 90ft. on a residence street, nor 110ft. on a business street, except on business streets and avenues 160ft. wide, where a height not exceeding 130ft. may be allowed. Wooden or frame buildings are restricted to three storeys or 40ft. in height to the roof.

THE Registrar General reports that the deaths registered last week in thirty-three great towns of England and Wales corresponded to an annual rate of 17·8 per thousand of their aggregate population, which is estimated at 11,218,378 persons in the middle of this year. The deaths registered in each of the last four weeks in the several towns, alphabetically arranged, corresponded to the following annual rates per thousand:—Birkenhead, 14·3; Birmingham, 19·0; Blackburn, 17·6; Bolton, 21·3; Bradford, 16·3; Brighton, 18·8; Bristol, 17·8; Burnley, 13·8; Cardiff, 10·6; Croydon, 13·8; Derby, 13·4; Gateshead, 15·6; Halifax, 19·4; Huddersfield, 14·8; Hull, 15·0; Leeds, 17·8; Leicester, 12·5; Liverpool, 22·1; London, 17·0; Manchester, 23·0; Newcastle-on-Tyne, 18·9; Norwich, 15·4; Nottingham, 20·8; Oldham, 20·4; Plymouth, 18·4; Portsmouth, 14·2; Preston, 21·1; Salford, 25·4; Sheffield, 18·4; Sunderland, 17·0; Swansea, 30·2; West Ham, 14·7; Wolverhampton, 12·4.

M. DUSSAUD has studied the best means of intensifying the sound transmitted by a microphone to a telephone receiver, says the *Electrician*. He produced a steady sound by means of an electrically-driven tuning fork placed in front of an extremely sensitive microphone. At the receiver end the circuit divided into four branches, each actuating a separate telephone membrane. M. Dussaud tried various combinations of the four receivers, and found that the more numerous they were the louder was the sound. It was also found advantageous to collect the vibrations from both sides of the membranes. He employed a set of collecting tubes, all leading into a resonator of the shape and size of a human mouth. He thus was enabled to reproduce the sound of wind instruments and the human voice in a large hall accommodating 1000 persons, and with such loudness that they could be heard in every part of the hall. On the State telephone system of Geneva, communication was established between two subscribers in such a manner that ordinary speech could be heard in every part of the room. As only two Leclanché batteries were used, the increased efficiency was solely due to the new arrangement for transmission.

AN interesting scheme for imparting to boys a higher commercial education than is usually obtainable in this country is about to be tried on the modern side at the Clayesmore School, Enfield, in Middlesex, commencing next term. After a preparatory period—the curriculum for which comprises the study of French, German, mathematics, drawing, and English subjects, such as Scripture, history, geography—the boys at about the age of fifteen will have to take up the second period. The work in this will include (1) French and German, with a special view to practical uses; when sufficient proficiency has been attained, a third language can be added, *e.g.*, Italian, Spanish, &c.; (2) More advanced mathematics with a special view to the application of mathematics to scientific pursuits and engineering; (3) Machine drawing; (4) The history of commerce; (5) Geography, with special reference to commercial interests; (6) Political economy, with special reference to finance, banking, and labour questions; (7) Laboratory work in chemistry and physics; (8) Book-keeping, &c. Such an experiment will be watched with considerable interest, as there is no doubt that similar educational schemes have been successful on the Continent.

AMONG the private Bills relating to new water schemes other than those promoted by the London County Council is one promoted by the West Middlesex Waterworks Company. This corporation has deposited a measure to confer further powers upon itself with respect to the construction of works, taking of water from the river Thames, raising further capital, and for other purposes. The preamble of this Bill declares it to be expedient that, pending the completion of the works authorised by the Act of 1896 and the Staines Reservoirs Act of 1898, the company should be empowered to draw from the Thames a further quantity of 24,500,000 gallons, which they are now entitled to draw, on any one day. The company may, if the Bill becomes law, raise additional capital, not exceeding in the whole £250,000, by the creation and issue of debenture stock. Another of the measures is the Metropolitan Waterworks Company's Bill. Under this measure it is proposed, "with the view of obviating the possibility of a deficiency in time of drought, or by reason of accident, or in cases of emergency in the quantity of water which any one or more of the metropolitan water companies may be able to supply within their district or districts, that provision should be made for improving and facilitating intercommunication between the mains and works of those companies respectively, and that such obligations shall be imposed upon those companies, and such powers given to the Local Government Board, and such provisions made as is in the Act contained." The Local Government Board is to be empowered to sanction such quantity of water to be taken temporarily from the Thames and its tributaries as in the opinion of the Board may be necessary for preventing any deficiency in the supply of water within the district of any of the companies. The East London Waterworks Company have deposited a Bill to enable them, with the sanction of the Local Government Board, to take further water from the river Thames in cases of exceptional drought and other emergencies, and another Bill to authorise them to construct additional storage reservoirs and other works, and to enable them to raise further capital by the creation and issue of debenture stock in a sum or sums not exceeding in the whole £1,500,000.

MISCELLANEA.

THE Automobile Club of Great Britain and Ireland intends to hold a show of self-moving vehicles next year in the Old Deer Park at Richmond, Surrey, from Saturday, June 24th, until Saturday, July 1st, inclusive. With the provision of suitable buildings for housing the cars, probably no more suitable place could have been chosen.

IT is reported that the largest order for water-tube boilers ever given in America is that which the Cramp Company, Philadelphia, has just given to the Stirling Company, of Chicago, for the water-tube marine boilers for Russian war vessels, now under construction at the Cramp yards, amounting to about 35,000-horse power.

A BODY called the Employers' Parliamentary Council, having offices at 7, Victoria-street, Westminster, has been formed, representing the Employers' Association of the United Kingdom. The president is the Earl of Wemyss; vice-presidents, Sir W. T. Lewis, Sir Benjamin C. Browne, Mr. George Livesey, Mr. Thomas L. Devitt, and Mr. Alexander Siemens. The secretary *pro tem.*, is Mr. Frederick Millar.

PREPARATIONS are being made at Chatham Dockyard for laying down a new battleship of the first class in No. 7 slip. The first keel plate will be placed in position within a few days. The vessel will be named the Venerable, and will have a displacement of 15,000 tons. A powerful armament is being provided for the Venerable, in which the 12in. forty-six-ton breech-loading wire guns will be the principal feature.

THE small type of mail packets—the Maid of Kent, Prince, and Wave—which for over thirty years did excellent work in the cross-Channel service between Dover and Calais, have just been stripped prior to being sent to Tilbury. It is stated that the Samphire, Breeze, and France, three well-known vessels of the same class, which were sent to Tilbury some time ago, have been purchased by a Dutch shipping firm.

THE first transatlantic mail from Liverpool since the establishment of Imperial penny postage was taken out on Wednesday afternoon by the White Star liner Majestic for New York. It consisted of 430 sacks, which is a larger quantity than usual for this period of the year, and the Majestic was also expected to ship a very large quantity at Queenstown. Nine-tenths of the letters sent to Canada by the Majestic bore only a penny stamp.

ACCORDING to the Chicago correspondent of the *Standard*, one of the greatest steel plants in the United States has been organised by a combination of the Federal Steel Company, the Pullman Company, and the Titan Company, representing Mannesman Brothers, who have a process for manufacturing projectiles. The Mannesman's firm had a contract with the United States Government for shells far exceeding three million dollars; but the war was brought to a close before delivery began. The United States Government has now confirmed that contract, and the same process will be applied to casting hollow car axles and armour plate.

ACCORDING to a New York correspondent of the *Standard*, General Miles, the Commander-in-Chief of the U.S. Army, is both amazed and delighted with the trials which have taken place with Mr. Gatling's cast steel cannon. The weapons were repeatedly fired at a pressure exceeding double the service maximum charge. The castings are of secret alloys, and after completion are exposed to two thousand degrees of exterior heat with a cold blast through the bore. Discoloration, beginning in the interior, reaches the exterior in six hours, and this marks the completion of the process. Mr. Gatling says the cannon are producible at half the cost of built-up guns, and can be turned out in one-eighth of the time.

THE gale of Tuesday last has been accountable for considerable damage to the National Harbour Works at Dover. An examination on Wednesday of the works in connection with the western arm showed that a large girder off the top of the turret at the end of the pier has been bent by the sea, notwithstanding that it is a considerable distance above the sea level. Huge piles swept away from this work were found at East Cliff. The piles, which were 105ft. long and 20in. square, were broken to pieces by the force of the sea. All the works on the top of the turret, where there are several cranes, have, however, stood remarkably well, no damage whatever being incurred.

THE prize sheet for live stock, poultry, produce, implements, &c., at the country meeting of the Royal Agricultural Society to be held at Maidstone from June 19th to 23rd next, has now been issued. In the implement department the Society will offer a prize of £50 for hop-washing machines, and prizes of £20 and £10 in two classes for cream separators, to be worked by power and by hand respectively. The Maidstone Local Committee also offer a prize of £20 for the best machine for the evaporation of fruit and vegetables, and two prizes of £5 each for the best package for the carriage of soft fruit and for the carriage of hard fruit. The entries for these classes close on April 1st. It will be noted that no prizes will be awarded for self-moving vehicles.

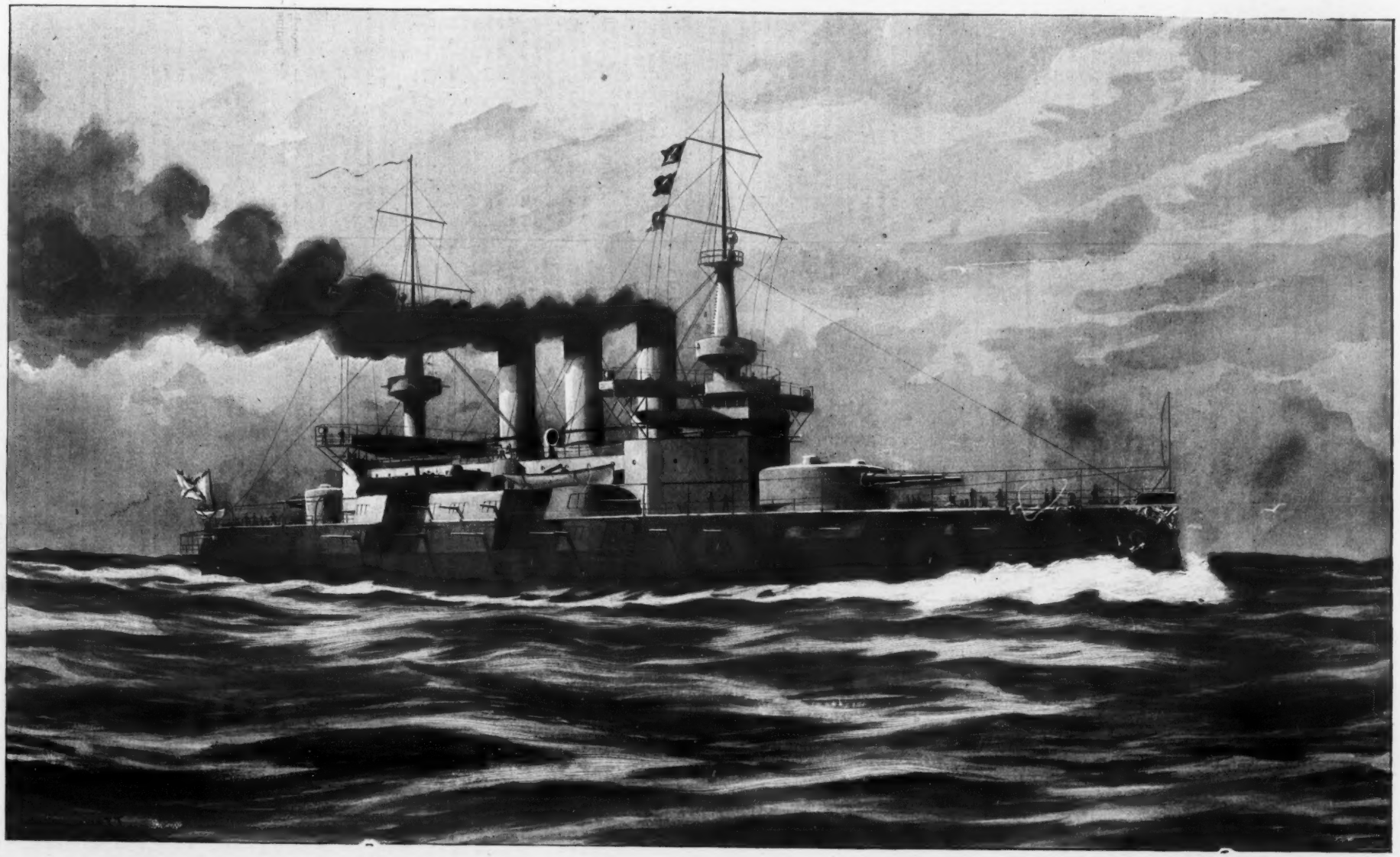
AN important work in connection with the Buffalo River in Buffalo, N.Y., has reached the stage of completion of plans and specifications, which are now to be submitted to the Board of Public Works with a request for the issue of proposals. This work contemplates the widening, straightening, and deepening of Buffalo River, between Hamburg-street, and the east city line, and also of Cazenovia Creek, from its junction with the river to Cazenovia-street. The plan for the river proposes a bottom width of 230ft. to the creek, 150ft. beyond the creek, and 120ft. in Cazenovia Creek. The sides are to be dyked 15ft. above the normal water surface, and the estimated quantity of material to be moved is 3,000,000 cubic yards. The estimated cost of dredging is about 700,000 dols. Five highway and six railway bridges, crossing these streams, will have to be altered.

THE *Times* publishes a letter from a correspondent, evidently a passenger on board at the time, giving details of the loss by the Austral of one of the blades of her propeller. The accident, which we briefly noted at the time, took place soon after the vessel left Suez for Colombo, on Friday, October 14th. Two attempts were made to continue the voyage with only the three blades remaining, but this was found to be impossible, owing to the large amount of vibration set up, and the vessel returned to Suez. Here there was no dry dock big enough to accommodate her, and the repairs had to be carried out by divers in wet dock. Five broken studs, between 2in. and 3in. in diameter, had to be extracted, and the method adopted was to drill holes in these and drive in wedges, which could be turned by a spanner actuated by means of connections made with the after winches. New studs were then fixed, and the propeller, a spare one carried on board, was fitted—still by divers—the work being completed ten days after the vessel returned to Suez. The *Times* correspondent tells us that of the ten studs holding the original blade five were broken and had to be taken out, four of the remaining bolts were absolutely intact, while one had its thread slightly injured. This, and the fact that there was no sign of "shearing," is taken as being suggestive of the nuts having come unscrewed, and it is said that when, on arrival at Colombo from Suez, after the repairs had been carried out, the nuts were examined, they were all found to have loosened slightly. Another point alluded to is the fact that the spare blade was of steel, and not, as were the remaining blades, of bronze. The result was a difference in weight amounting to some half a ton in the new blade, and the unevenness of stroke and concussive effect due to this unequal distribution of weight were quite noticeable.

NEW RUSSIAN BATTLESHIP

MESSRS. WILLIAM CRAMP AND SON'S SHIP AND ENGINE BUILDING COMPANY, PHILADELPHIA, BUILDERS

(*For description see page* 638)



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Prices for Displayed Advertisements in "ordinary" and "special" positions will be sent on application.

Advertisements cannot be inserted unless delivered before Six o'clock on Thursday evening; and, in consequence of the necessity for going to press early with a portion of the edition, ALTERATIONS to standing advertisements should arrive not later than Three o'clock on Wednesday afternoon in each week.

Letters relating to Advertisements and the Publishing Department of the Paper are to be addressed to the Publisher, Mr. Sydney White; all other letters to be addressed to the Editor of THE ENGINEER.

Telegraphic Address, "ENGINEER NEWSPAPER, LONDON."

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TO CORRESPONDENTS.

*** *In order to avoid trouble and confusion we find it necessary to inform correspondents that letters of inquiry addressed to the public, and intended for insertion in this column, must in all cases be accompanied by a large envelope legibly directed by the writer to himself, and stamped, in order that answers received by us may be forwarded to their destination. No notice can be taken of communications which do not comply with these instructions.*

*** *All letters intended for insertion in* THE ENGINEER, *or containing questions, should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *We cannot undertake to return drawings or manuscripts; we must, therefore, request correspondents to keep copies.*

INQUIRIES.

"LUCAL" LAMPS.

SIR,—We shall be obliged by the address of makers of the Lucal lamp.
Bishopsgate-street Within, December 28th. T. AND CO.

MEETINGS NEXT WEEK.

SOCIETY OF ARTS.—Wednesday, January 4th, at 7 p.m. Juvenile Lecture on "Hands and Feet," by Prof. F. Jeffrey Bell.

THE CIVIL AND MECHANICAL ENGINEERS' SOCIETY.—Thursday, January 5th, at 7.30 p.m., at the Hotel Victoria, Northumberland-avenue, W.C. Paper, "Retaining Walls," by A. T. Walmisley, M.I.C.E.

ROYAL INSTITUTION OF GREAT BRITAIN.—Tuesday, Thursday, and Saturday, January 3rd, 5th, and 7th, at 3 p.m., Afternoon Lectures on "Astronomy," by Sir Robert Stawell Ball, D.Sc., LL.D., F.R.S.

GEOLOGISTS' ASSOCIATION, LONDON.—Friday, January 6th, at 8 p.m., at University College, Gower-street, W.C. Paper, "The Glaciers and Fjords of the Bergen District, Norway," by Mr. Horace W. Monckton, F.L.S., F.G.S.

THE ENGINEER.

DECEMBER 30, 1898.

VENTILATION.

THE fact that two evenings should have been entirely devoted by the Institution of Civil Engineers to the discussion of a paper is evidence either that the subject is very important and contentious, or that the paper is extremely good, and perhaps it is evidence of both, as we venture to think is the case with the paper by Mr. Francis Fox, on the "Ventilation of Tunnels and Buildings," recently read at the Institution. This paper has evidently been prepared with extreme care, and it was sufficiently interesting. Railway tunnels were first dealt with, and it was laid down as a practical working limit that the air in a tunnel is satisfactory if there are only 20 parts of carbon dioxide in 10,000; and the difficulties of maintaining this standard of purity were dwelt upon, not only in the paper, but in the discussion, and many very useful points were elicited. During the discussion it became amply evident that no hard-and-fast rule could be laid down as to the method to be adopted in ventilating tunnels, and that each case must be decided on its own merits. There was only one solitary point on which everyone seemed to agree. It was that the proper means of running trains in tunnels was electricity, and only one discordant note was struck. A gloomy prophecy was made that when we got our electric traction we should not be entirely satisfied after all, and the stuffiness of the City and South London Railway was brought in in evidence. Now, the air in that place may be, according to chemical analysis, perfectly fit for human consumption, and yet may be distinctly objectionable to the human nose. Our own opinion is that if they had a good blow through, or "suck" through, even as seldom as once a day, these underground lines would be quite free from anything either objectionable to our sense of smell or injurious to our health. The failings of the Underground Railway were brought forward and covered up by succeeding speakers, and then brought forward again in all their nakedness. Eighty-six! No! 89 parts of carbon dioxide in 10,000 parts were discovered in its deepest recesses, and one trembled to think that perhaps no drivers would be there to take us to our destinations after the meeting was over. They were there, though, in spite of the fact that the Underground Railway may be four times as bad as the Mersey Tunnel, and they looked fairly healthy too. All speakers agreed, however, that even the "Underground" would be improved by electric traction. The Saccardo system of ventilation was highly commended and described in detail by the author, who considers that it is one of the greatest inventions in connection with tunnel ventilation of late years. In the discussion, however, it did not obtain much notice, probably because few English engineers have had much experience of its working.

The practical results of bad ventilation in tunnels received a considerable amount of attention; and some useful figures were brought forward showing the rate of wear of rails. The Mont Cenis Tunnel requires 300 tons of new rails per annum, the Great Western Railway find as much as 2¼ lb. per yard per annum wear in the Box Tunnel, and the Great Northern as much as 2 lb. in some of its tunnels. This, combined with the disastrous effects tunnel air has upon platelayers, engine drivers, &c., in those tunnels where ventilation is bad, make it very evident that an efficient system of ventilation should be applied in every tunnel of any considerable length. To go through the Penge Tunnel, for instance, though it is not quite so bad now as it used to be, perhaps, is decidedly a punishment. From the remarks of several speakers it could be gathered that shaft ventilation did not always act perfectly—far from it. Blowholes, which are shafts in miniature, and can only be used where the tunnel is but a few feet below the ground level, were by some advocated most strongly, and by others declared to be worse than useless. What are we to think? Again, has fan ventilation been properly tried on the Metropolitan Railway? "Yes," said one speaker; "not properly," said another. Of course we heard something of the Blackwall Tunnel. Here preparation was made for ventilation, and behold, none was required. Truly each tunnel must be ventilated as suits its own particular requirements, and it would seem almost impossible to judge beforehand what these requirements are likely to be. With reference to the making of the tunnels, especially when compressed air is being used, great stress was laid upon the necessity of continuously testing the air by chemical means, the amount of carbon dioxide present being a measure of the impurity of the air.

And then as to buildings. Here was contained the *raison d'être* of the paper, and it was kept snugly wrapped up until right at the end. The prime object which Mr. Francis Fox had in writing the paper was to improve the condition of the Committee Rooms of the Houses of Parliament. To anyone who is accustomed to be in these rooms the necessity of improvement need not be explained. Mr. Preece was only describing the condition of everyone when he said that he never went away from Committee without a headache. It is terribly fatiguing to sit all day in a stifling atmosphere. Mr. Francis Fox regards it most seriously, and we cannot think he was joking when he said that he considered that the valuable lives of some of our greatest engineers were being endangered. He did not seem to be so concerned as regards the lives of the unfortunate members of Parliament who also are compelled to stay in the Committee Rooms. The discussion on the subject of the ventilation of rooms called forth some interesting facts. Mr. Fox in his paper said that 70,000 people died annually from tuberculosis, and that the vast majority of these deaths could be prevented by proper ventilation. He was taken to task on this point, it being suggested that milk was a greater offender. Mr. Fox, in his reply, apologised for a mistake — 70,000 was right at the time the paper from which he got his authority was published. It was now about 60,000 deaths per annum. Again, he insisted that the vast majority of these could be prevented by good ventilation and sunshine; and as to milk, he said that the filthy and unsanitary condition of English cowsheds was a byeword. The ventilation of various hospitals was discussed, and also the ventilation of the theatre of the Institution. It was held up as being a model of what it should be by some, and again there were others who complained of draughts. Indeed, the ventilation, or rather the goodness of the ventilation of this theatre, may be said to depend upon where you sit. The knowing ones are aware of an up draught, which renders the legs so cold that one wonders what is the matter, and decides that, to admit cold air as practised in the Institution theatre, is not the correct way by any means. The knowing ones sit where there is no draught, and are comfortable, for, without doubt, the bad air, air which has been through the lungs—"air sewage" Mr. Fox most aptly called it—is efficiently removed by the electric fans. Churches and public halls came under discussion, but the greatest interest was centred round the Houses of Parliament. The existing arrangements were ably described and said to be ample. They consisted of up-draught furnaces. But from evidence adduced, it would appear that they were inadequate, seeing that an anemometer failed to descry any motion of air whatever. It was explained, however, that the provisions were ample, if proper mechanical means were supplied to make them work efficiently. These means, it was intimated, were being provided, so perhaps the lives of our engineers may not be much longer in jeopardy on this account. With regard to ordinary buildings, Sir Douglas Galton made a most pertinent remark: "Why not open the windows?" If there were more windows opened, especially at night, there would be a vast improvement in the general health of the community.

THE BURSTING OF FLY-WHEELS.

EVERY now and then a fly-wheel bursts in this country; a building is wrecked, and workmen lose their lives. The catastrophe occurs because for some reason the engine runs away, and the centrifugal force is too great for the cohesion of the wheel. In the United States such fractures are far more common than with us, and they take place sometimes when the engine is not running away. Every engineer is supposed to be able to calculate the bursting stress of a wheel in terms of centrifugal force by the formula $c = \frac{w v^2}{32 \cdot 2 r}$, where v is the circumferential velocity in feet per second, w the weight, c the centrifugal force, and r the radius of gyration. Also, every mechanical engineer is supposed to know that the maximum safe speed for a cast iron fly-wheel rim is 100ft. per second, and it is taken for granted that so long as this velocity is not exceeded no risk is incurred. If a wheel is to be run at a higher speed, it is either made of cast steel, or is hooped with wrought iron or steel. But notwithstanding all this common knowledge, there is good reason to think that numbers of fly-wheels are run at considerable though quite unrecognised risk. Partly because the casting is not quite sound; partly because the wheel is built up of segments bolted or hooped together; and, lastly, because the effect of bending on a thin rim has not been taken duly into account. The English literature of the fly-wheel is very limited. No one seems to have taken any trouble about the fly-wheel. It is regarded only as a sort of necessary evil, and as we have said, so long as there is reason to believe that as a casting it is quite sound, and as part of a machine it does not run at a higher speed than 100ft. per second, all is safe. In rolling mill work, however, the fly-wheel is not only run at a very high speed, but very liable to be pulled up abruptly. Very heavy transverse stresses are set up in the arms. We have ourselves seen a fly-wheel rim pitched clean off its arms, and another pitched off the six keys by which it was secured on a hexagonal seat. Something about these stresses may be found in most treatises on the steam engine, but all, or nearly all, that has been written is based on theory.

In the United States a meritorious effort has been made

to get at some facts, and the results of a series of experiments carried out at the laboratories of the Case School of Applied Sciences by Mr. Charles H. Benjamin, assisted by two of the students, have formed the subject of a paper read by Mr. Benjamin in November before the American Society of Mechanical Engineers. The experiment was carried out with small wheels varying between 15in. and 24in. in diameter, and weighing from 20 lb. to 95 lb. each. The experiments were by no means free from danger. The wheels were placed inside a species of A frame like a couple of rafters in the same plane as the wheels. These rafters received the flying fragments. How great was the force with which these were discharged will be realised when we say that white oak timbers, 12in. by 12in., were split and riven by segments of the wheels. The apparatus consisted of a steam turbine, to the shaft of which the fly-wheel to be broken was coupled by a flexible pin joint. The fly-wheels were carefully balanced by winding short lengths of copper wire round an arm. After various devices for measuring the velocity had been tried, it was found that the musical note of the wheel when running at speed could be compared by means of tuning forks with an electrical speed counter called an ear-phone, consequently the ear-phone was discarded. "Two observers, having trained musical ears and provided with tuning forks, had no difficulty in determining the pitch within half a tone, the quarter tones being estimated. The error due to this method did not exceed 5 per cent., and was probably less than if an attempt had been made to get the speed with a tachometer. The bursting speed of the wheels having rim joints was too low to produce a musical tone with any distinctness, and it became necessary to resort to the tachometer. It was not deemed safe for the observers to apply the instrument directly to the fly-wheel shaft, and a countershaft reducing the speed from two to three times was employed." What took place when a wheel burst is graphically given in a few words by Mr. Robinson:—"In none of the experiments was there any shaking or tremor, only a dull roar of increasing intensity, then a single sharp report and quiet, except for the hum of the relieved turbine."

The results obtained are by no means reassuring. Thus one pair of 12in. wheels gave way at 6525 revolutions per minute, corresponding to an angular velocity of 430ft. per second. That is to say, the nominal factor of safety of such a wheel running at 100ft. per second would have been only 4·3. But other wheels failed at 395ft. and 380ft. per second. The cast iron of which the wheels were made had a tensile strength of 8·48 tons per square inch, and the outer skin had not been turned off. The shape of fracture at the outer ends of the arms in all the wheels usually indicated that the rim broke just midway between the arms, and that then the two parts of the rim flew outward, and broke off at the arm. Although at first sight it seems strange that a little 12in. wheel should, by flying to bits, be competent to split heavy oak timbers, there is really nothing curious about the matter. The fragments were despatched at a tangent to the wheel, and at the same velocity as that at which the rim was revolving. A velocity of nearly 400ft. per second is quite comparable to that of projectiles. It was probably greater than that of the shot with which many of our great naval battles were fought and won. The stored-up energy in each pound of the wheel was 2500 foot-pounds. It would be competent to exert a force of 5000 lb. over a space of six inches, or to carry the fragment to a height of 2500ft., or about seven times the height of St. Paul's Cathedral. Bearing these facts in mind, it is not wonderful that the bursting of a fly-wheel causes wholesale destruction to property.

Fly-wheels cast in one piece are always of comparatively small size. Probably the most useful portion of Mr. Robinson's inquiry is that devoted to built-up fly-wheels. It is true that he could only try models up to 24in. in diameter, but there is no reason to doubt that what he found true of the model would be found equally true of a large wheel. The built-up wheel is not nearly so strong as the solid wheel, and this is no doubt the reason why so many fly-wheels burst. The experiments were directed to ascertain the best method of securing the segments; in the first place, bolts through flanges on the inside of the rim were tried. Such wheels failed at speeds as low as 189ft. per second. A peculiar bending action on the bolts is set up, and in one instance the bolts were nearly sheared through. The bursting rim speed of the built-up wheel is about one-half and the centrifugal force about one-fourth of that of the solid wheel. The third set of experiments was devoted to ascertaining the behaviour of linked joints; that is to say, of those joints in which rings or stirrups of wrought iron are shrunk over projections cast on the rim to receive them. These are better by about 60 per cent. than the bolted joint. The general conclusions of Mr. Robinson are that well-made solid wheels of good proportions are quite safe up to a speed of 100ft. per second. Thus a wheel 46in. in diameter, such as may be found on traction and ploughing engines, would be safe up to 500 revolutions per minute. Such a wheel, made in halves and bolted together, would not be safe at half that speed. Joints, when necessary, should always be close to an arm. In Mr. Robinson's words, "They are as serious mistakes in design as would be a joint in the middle of a girder under a heavy load." Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for fly-wheels. Under the most favourable circumstances they have only about one-fourth the strength of the solid rim, and are particularly weak against bending, and the bending of the rim between the arms is a very important factor. It might be supposed that a thin rimmed would be stronger than a thick-rimmed wheel, because the weight would be reduced. But in point of fact the thick rim is the stronger, mainly because the thin rim bends more easily under the stress of centrifugal force. The best joint is made with three straps, one at each side, and one inside the rim. No attempt was made to test the key and dowell joint, probably because the wheels were so small.

At the same meeting a "note" on the strength of wheel rims was read by Mr. A. K. Mansfield, of Salem, Ohio, in which he points out that ribbing fly-wheels at each side on the inner face of the rim, a common enough arrangement, may weaken the wheel, for reasons which he gives, and he advocates the use of a deep curved rib reaching from arm to arm all round the wheel, the cross section of which becomes a T. We have no reason to doubt that a very excellent wheel can be made in this way. It may be easily enough gathered from what we have said that fly-wheels have a very large margin of safety, because, as a rule, they are not run at nearly 100ft. per second. But rope driving at a mile a minute, or 88ft. per second, is by no means unknown, and belt pulleys sometimes run even faster than that, as, for example, in wood-working machinery. In any case it ought to be very clearly understood that excellence of workmanship and quality are essential. It is too much the habit to regard a fly-wheel as something to be bought by the ton, a little better, but not much, than fire-bars. For slow speeds and small stresses this may be all right, but in rolling mills it is all wrong, and rolling mills are just the places where least thought is given to the fly-wheel. The fly-wheels in some old-fashioned rolling mills are about as safe as gunpowder magazines.

THE EXHAUSTION OF GUTTA-PERCHA.

THE international network of submarine telegraphs has become such an important factor in political and commercial activity, that one can scarcely realise the consequences which would result if this system were to be thrown out of gear or destroyed. Nevertheless, if we are to believe certain prophets, whose pessimistic views are only too strongly supported by evidence, the world is threatened with the loss of the submarine cables. A writer in the *Revue des Deux Mondes*, M. Lazare Weiller, who is competent to speak on this subject, utters somewhat timidly the first note of alarm. He has been followed by M. Adolphe Combanaire, another specialist of higher standing, who has exposed in the *Electricien* the danger that threatens submarine cables. According to this writer, the days of these cables are numbered. In ten years, or perhaps sooner, an irreparable breach will occur in this endless network which runs round the globe, and the electric messages will then be discharged into the depths of the ocean, where they will remain. A mere detail will have sufficed to disorganise the working of the system, and to paralyse the telegraphic intercourse of the world. This detail, which at present seems to trouble nobody, is the exhaustion of gutta-percha. This substance has been discovered nearly sixty years; contrary to ordinary caoutchouc, it has the curious property of becoming soft in boiling water, and is thus capable of being very easily moulded into any shape; then, under the influence of cold, it assumes an extreme hardness. Ever since the first cable was laid between Dover and Calais, on November 13th, 1851, the use of gutta-percha has been an absolute necessity. In vain have skilled scientists made experiments with a view of substituting other materials of a similar nature in place of gutta-percha; these efforts proved to be fruitless, and the attempt was finally abandoned. The difficulty was further increased by the fact that not every kind of gutta-percha was found to be equally useful in protecting submarine cables, and in the end only two kinds, produced exclusively in a district several hundreds of leagues in extent in the neighbourhood of Singapore, were alone made use of. It is only in this region, and nowhere else, that the regularity of the climate, the constancy of an extreme temperature, marvellous humidity, and the volcanic character of the soil, all unite in forming a sort of hot-house, in which the plant can produce abundantly, and in a lasting manner in its tissues those essential oils on which its properties seem to depend. Other guttas, when once submerged in water, very quickly begin either to exude gutta or to undergo atomic changes, which processes at once render them useless. Although there exist several varieties of trees which produce good gutta, there is, unfortunately, only one method of gathering it; it is a wasteful method, for it consists in cutting down the trees. In fact, contrary to the method adopted in the case of caoutchouc and intermediary gums, simple incisions made in the bark of the percha tree are not enough. At this rate gutta-percha will soon be a thing of the past. When the report got abroad recently that an American cable was to be laid across the Pacific Ocean from San Francisco to Tokyo by way of the Sandwich Islands, and with branches to the Ladrones and Manila, the price of gutta-percha rose in a few days from 40 to 50 per cent. M. Combanaire also says that it would be impossible to find in France at this moment ten tons weight of matured gutta fit to be used in making a submarine cable. Is there no way of remedying the gravity of the situation? Until a new substance shall have been discovered capable of taking the place of gutta-percha, there is only one remedy, and that is the formation of nurseries for promoting the growth of the tree on a systematic plan; these trees must be treated as game is treated if they are not to disappear from the face of the earth. There is little doubt that Java, Borneo, and Sumatra would afford a favourable ground for experimenting with the cultivation of this precious tree, whose product has become so highly essential to the continued intercourse between the nations of the world.

OVERTIME IN THE MIDLANDS.

AN important agitation has been on foot for some time past among the operative engineers in Birmingham and the district for a re-arrangement of the basis of overtime payment. The movement has now issued in the circularisation by the Birmingham Committee of the Amalgamated Society of Engineers of a new set of rules to the employers' firms. Hitherto the men have received pay at the rate of time and a-quarter for the first four hours worked after ordinary hours, and subsequently at the rate of time and a-half. Another important condition obtaining up to now is that overtime shall be calculated on the week's work and not on each day independently, which means that the increased rates are only payable on time worked in excess of the regular week of fifty-three hours. The Birmingham workmen now claim that "in view of the rates which prevail in other of the large engineering centres," they are entitled to time and a-quarter for the first two hours, and time and a-half after that; and that instead of the excess being reckoned on the fifty-three hours' week, it should be reckoned from five o'clock each evening. Double time is also demanded for Sunday work instead of time and a-half. Further, amendments are asked for in the working rules, "with a view to improving the position of the younger operatives," and to ensure a certain minimum of remuneration for piecework. The Amalgamated circular, which is accompanied by an intimation that the new rules will come into force on January 1st, has occasioned considerable dissatisfaction amongst the employer firms. The Birmingham, Wolverhampton, and District Engineering Trades Employers' Association, which was formed at the close of the late strike, have intimated to the Society that they see no reason for the alterations suggested, and that they are of opinion that they are not in the best interests of the trade. This reply will, it is understood, be submitted to a meeting of the men, with whom it will rest to determine the course to be pursued. The number of operatives to whom the new rules are sought to be applied is between 2000 and 3000, and the leaders deny that the new rules are primarily intended to raise the rates of pay, but say candidly they are rather to prevent overtime as far as possible. It is impossible yet to tell what will be the issue of the present position. The operatives may, in the event of negotiations failing, elect of their own free will to come out on strike. But the granting or withholding of pecuniary support from the central exchequer, without which, of course, no conflict could be successfully waged, rests, it is satisfactory to know, with the Council of the Amalgamated Society in London. It is earnestly to be hoped that, considering the importance of Birmingham as an engineering centre, no rupture between employers and employed will be allowed to occur until the utmost has been done to bring about an amicable settlement. Such a situation on the eve of what promises to be the best year of trade that we have enjoyed for seven years past would be an untold calamity. Happily the employers are sufficiently combined to be able to successfully resist any unfair demands by the men, should it become necessary to take extreme measures; but any such a step as a lock-out will, it is sincerely hoped, be avoided. It will be remembered that at the time of the late great strike Birmingham was practically free from any paralysis of trade, the employers here not seeing their way until the very end of the conflict to take sides in the struggle, and then only to an extremely limited extent.

LITERATURE.

The University Tutorial Series: A Middle Algebra, based on the Algebra of Radhakrishnan. By WILLIAM BRIGGS, M.A., and G. H. BRYAN, Sc.D. London: W. B. Clive, Booksellers'-row, Strand, W.C.

WHEN it is considered that the Arabs, who formed the chief link of communication between the East and the West, were the pupils of Hindu mathematicians, it is not perhaps so "singular" that a modern algebraic text-book should be based upon the Indian treatise of Professor Radhakrishnan. In the present volume, which is more especially intended for the use of candidates preparing for examinations of a rather more advanced and difficult character than those of simple University matriculations, a certain amount of previous knowledge on the whole subject is necessary. They must be conversant with algebra as far as the three Progressions, and the general principles of quadratic equations. Passing over the first couple of chapters on indices and surds, a short space is devoted to "Inequalities," which are treated separately, and only so far as is sufficient to demonstrate the usual laws and rules which govern them. A more extended investigation into their application to the comparison of ratios, and arithmetical and geometrical means, is fully entered into in subsequent chapters.

About a hundred pages of the volume are devoted to ratio, proportion, variation, and quadratic equations with two or three unknown quantities. The remarks respecting "Surd Solutions," in which case irrational results sometimes are completely inapplicable, are well worth the attention of the student. So also are the examples adduced of impossible solutions, and of instances in which all solutions are found to fail. It is well observed of Surd solutions, that "even when they can be admitted as proper solutions, they furnish us with endless decimals or quantities that cannot be determined exactly." The important properties of zero and infinity are very often but imperfectly understood by beginners, who will find them both clearly and accurately defined in the present treatise. The theory of quadratic equations and maxima and minima are treated of at some length, which will enable the reader fully to comprehend the meaning of a function, an algebraical term frequently not defined with the proper degree of accuracy and precision in some of the text-books prescribed for an ordinary scholastic curriculum. We prefer the term symbolical as a distinguishing characteristic of algebra when contrasted with arithmetic, to that of "literal," which is a quantity in contradistinction to a numerical quantity represented by a letter instead of a number.

There are numerous signs and prefixes employed in algebra which are not in any sense letters, and though they have been forcibly engrafted on arithmetic, do not, strictly speaking, belong to it. Many years ago algebra was defined as hardly more than a convenient shorthand for answering problems in arithmetic. In the fifteenth century signs were not used in the one or two existing treatises on the subject, but p and m were written for plus and minus.

Chapter XVI. introduces a somewhat new combination under the title of "Some Other Simple Series," including the "Arithmetic-Geometrical Series," which is formed by multiplying together term by term an arithmetical and geometrical progression. Perhaps the less stated about its simplicity the better, but it is successfully applied by the authors in determining the number of spherical balls—usually shot and shell—in triangular, square, and rectangularly-shaped piles or masses of those materials. There are, we believe, less complicated methods of arriving at the same result. Not undeservedly, although the subjects are rather trite, logarithms and interest have been very fully treated, partly on account of their commercial importance. As a matter of fact, interest and other ordinary commercial and business calculations are performed nearly altogether

by the use of various "Tables" for the purpose, which have been brought to a surprisingly accurate and finished degree of perfection. A good deal of confusion, no doubt, does exist in the minds of students respecting "Permutations and Combinations," and the plan adopted by the authors of treating them separately is a wise and judicious one. To those desiring to acquire a thorough knowledge of the branches of algebra forming the contents of the volume before us, it offers every facility. The definitions are exceedingly lucid and unambiguous, and it is very satisfactory to note that after the apparent solution of any equation by the student or reader, it is strongly insisted upon that it should be tested by ascertaining "by trial whether the values found are true arithmetical solutions of the problem." In other respects the volume is fully up to the standard of the "Series" to which it belongs.

Inspection of the Materials and Workmanship Employed in Construction. By AUSTIN T. BYRNE, Civil Engineer. First edition. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

THE duties of an inspector are many and various, and in order to carry them out in a thoroughly efficient manner he must possess an intimate acquaintance with the nature of work and with the qualities of the numerous different materials used in construction. A part of the knowledge so essential to him may be obtained from the information contained in treatises and text-books relating to civil engineering and architecture, but nothing but actual experience in the field and on works can enable him to judge of them and fit him for his position. The acquisition of the theoretical knowledge involves a great deal of labour and research, and sorting of the wheat from the chaff. In the volume before us the author has set himself the task of condensing, selecting, and adapting the various items of the matter required for the use of inspectors, superintendents, and those employed in the construction of public and private works. The contents comprise a very useful collection of memoranda pertaining to the duties of an inspector; the qualities, good and bad, and the suitability or otherwise of materials; the requisites for sound and durable work, and the necessity for detecting and providing against the attempts of careless and incompetent workmen to scamp the work. A strict adherence to the plans and specifications is indispensable, as they constitute the guide and standard in conformity with which the whole of the work has to be constructed. It is the enforcement of this condition which is the chief cause of disagreement between contractors and inspectors, and it calls for the exercise of a considerable amount of tact and firmness on the part of the inspector to avoid arguments, disputes, and quarrels.

Among structural materials, buildings, stones, bricks, and tiles, and the various descriptions of mortars, cements, natural and artificial, will always hold a foremost place. Concrete might, we think, have been appropriately included in this chapter, as it is closely akin to lime and cement mortars, both in composition, preparation, and mixing, but it is treated separately in another part of the volume. The author sums up his views respecting the efficacy of the different processes for ensuring the preservation of stonework from defacement and decay, by the remark that "all of the methods are expensive, and there is no evidence to show that they afford permanent protection to the stone," which opinion in the main is fairly correct. With timber the case is otherwise, as the employment of the few successful out of the many unsuccessful preservative solutions which have been introduced from the earliest times abundantly testify. Moreover, the adoption of these solutions enables a large proportion of the sapwood, which varies in thickness in different kinds of timber from about ¾in. to 4in. and 5in., to be safely utilised, which otherwise would be so much waste wood. The same result to a much more limited extent is obtained by a proper seasoning, and careful and liberal painting of the material. Under the head of "Metals" is included the composition and production of pig and cast iron, the manufacture of wrought iron and steel, together with brief descriptions of the Bessemer, the basic, the open-hearth, and the Siemens-Martin processes. The alloys of steel are particularised and classified, and so also are those of copper, lead, tin, and minerals in everyday use in the laboratory, and in refining operations. Steel intended for constructive purposes is frequently exposed to tests of a much more severe character than wrought iron, which is due to two principal causes. The one is that it is somewhat uncertain whether one satisfactory turnout of metal will be succeeded by another equally good in the required characteristics and properties, and the other that steel is more influenced by the operations of rolling, hardening, and overheating. These statements were no doubt perfectly valid some years ago; but so many improvements have been made in the production and working of that metal that the necessity of the more severe tests may at present be fairly questioned.

The subject of "Earthwork, Foundations, Masonry—of both stone and brick—and Carpentry," are treated of at some length in Sections 1 to 4 of Chapter III., and then a short space is allotted to the erection of iron and steel structures, the setting and connecting of beams, and the size of iron and steel lintels and girders. For the proper proportions and dimensions of these, reference is made to the rules and regulations laid down by the New York Building Laws of 1896. In "Fire-proof Floors" and the "Inspection of Roofing," it is pointed out that the latter calls for especial care and attention upon the part of the inspector, because of the difficulty of detecting unsound materials and bad and defective work after the roof is once erected. The next five sections are devoted to the consideration of subjects more immediately related to architectural and building than to engineering work, and comprise plumbing, glass and glazing, plastering and painting. There are some very useful remarks respecting the tests to be applied for ascertaining the soundness of the plumbing in houses, which deserve notice. For the health of the occupiers, and frequently of other people besides, greatly depends upon the pipes being in a thoroughly tight and efficient condition. No less important in regard to the hygiene of large cities and towns are the questions of domestic water supply and drainage, using the terms in the sense they are applied to habitable dwellings, whether large or small. For the internal coating of main and subsidiary cast iron pipes, Mr. Byrne gives the preference to the well-known preservative process of Dr. Angus Smith, though the "Barff" method is also favourably mentioned. Dr. Smith's coating is practically a varnish, produced by the distillation of coal tar to a point which gets rid of all the naphtha, and the residue becomes completely deodorised. The varnish thus obtained may be used pure, or with a small percentage of linseed oil added to it. Asphaltum is sometimes substituted for the other materials in cast iron, wrought iron, and steel pipes. There are no less than eighty-five tables attached to the volume, embracing nearly everything connected with its contents that can be reduced to the tabular form, and including those relating to the areas and circumferences of circles, square and cube roots, and logarithms of numbers, and the usual natural computations of trigonometrical functions. While there is unquestionably a considerable amount of information in the author's treatise that is beyond the requirements of the average inspector, yet the work was not written for the benefit of any one particular class, but for all classes and grades of such officials, and each will find not only what he wants, but as much more as he may choose to acquire.

Manuel de l'Explorateur. Procédés de levers rapides et de détail. Determination astronomique des positions géographiques. Par E. BLIM, Ingénieur Chef du Service des Ponts et Chaussées Cochin Chine. M. ROLLET DE L'ISLE, Ingénieur Hydrographique de la Marine. Paris: Gauthier-Villars, Imprimeur-Libraire. Quai des Grands-Augustins, 55. 1899. Touts droits réservés.

THIS treatise is intended as a guide and an assistance to those who are engaged in the preliminary survey of proposed roads, railways, canals, and other engineering projects in distant colonies and in hitherto almost unexplored countries. It does not aim at describing the refinements in both theory and practice that are necessary in conducting an extensive and a national trigonometrical survey, but points out very clearly what is required, and what is sufficient for the purpose to be accomplished. The number of engineers engaged in preliminary exploration in foreign lands is very large. For preliminary survey there are simple and quick means at the surveyor's command, which will be all he requires, and he must leave to his successor the preparation of the contract surveys and plans.

There are four principal points to be attended to in the preliminary survey. The first is the distance traversed; the second, its direction or bearing; the third, the levels—that is, the section of the route lined out; and the fourth, the location and relative height of neighbouring objects, a detail which in many instances may be neglected.

In the first chapter the simple instruments in ordinary use for the rough tracing of engineering undertakings are described and explained, including pedometers, aneroid barometers, and the compass. All bearings are necessarily referred to the magnetic north, from which the true bearings are easily determinable. In the hundred and twenty pages comprising the second chapter we think the authors have departed from the course of instruction they prescribed to themselves in their preface. Some very complicated mathematical formulæ and calculations are introduced, which certainly do not accord with the "methodes simples et expéditives que nous allons exposer." Chapter III. is devoted to describing the usual method adopted for making a small survey by triangulation, in which the authors employ a chain or steel tape of 40ft. in length, which is rather short for measuring a base line of even very restricted dimensions with approximate accuracy.

For the reduction, or presumably also enlargement of plans, the pantographe is recommended in the treatise, but that primitive instrument has long since been discarded with us for the eidograph, a far more elegant and accurate implement. We are quite at one with our authors in their selection of the theodolite as the instrument *par excellence* for all the purposes of triangulation surveying, whether horizontal or vertical. They give the preference to it, to the complete exclusion of the marine sextant, because a great deal of practice is required before the manipulation of the latter can be sufficiently acquired to enable the operator to obtain the same results, which are far more readily ensured by the use of the theodolite. The term marine sextant is used to distinguish it from the box sextant, which is a very portable, handy little instrument, and not so much appreciated by surveyors as it should be. No mention is made of it in the volume under review, nor of the prismatic compass. Both these are exceedingly well adapted for filling in the details of surveys, the latter being much employed by the Royal Engineers in their trigonometrical surveying. While it might, perhaps, be too much to assert that the "Manuel de l'Explorateur" would be of very much use to the English engineer or surveyor, it will be of use to those for whose benefit it was written, and for those besides who understand the language in which it is written.

Differential and Integral Calculus, for Technical Schools and Colleges. By P. A. LAMBERT, M.A, Assistant Professor of Mathematics, Lehigh University. New York: The Macmillan Company. 1898.

THIS little work will serve a useful purpose, in introducing the Calculus in an agreeable guise to the first attention of the technical student. Like the same author's "Analytic Geometry," it proceeds on free and independent lines, stopping to illustrate a general theorem by some well-chosen simple examples. Integration and differentiation are considered simultaneously, but the author makes a dangerous concession in sanctioning the omission of dx in conjunction with $\int$, as in page 29, and elsewhere. This will lead to error and confusion where a new variable is to be substituted. Article II., on the "Indefinitely Large and Indefinitely Small," has a "gritty" taste, and is apt to make the beginner think that the Calculus is only an approximate method after all. The phrase on page 12—"the average velocity per hour"—should be amended by the author, here and elsewhere, in another edition; but the author has done well to choose the idea of velocity as a primary explanation of the meaning of a differential coefficient. The exponential theorem is kept out of sight as long as possible, as in Professor Perry's book. Two useful chapters on "Differential Equations" complete the work, which ought to serve a useful purpose, as not too alarming in size for a beginner.

BOOKS RECEIVED.

Journal of the Royal United Service Institution. December, 1898. London: J. J. Keliher and Co. Price 2s.

Compagnie des Installations Maritimes de Bruges: The Outer Port and the Inner Port of Bruges. Bruxelles: Imprimerie et Lithographie A. Lesigne. 1898.

Elements of Sanitary Engineering. By Mansfield Merriman. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898.

Annals of Coal Mining and the Coal Trade: The Invention of the Steam Engine and the origin of the Railway. By Robert L. Galloway. With numerous illustrations. London: The Colliery Guardian Company, Limited. 1898. Price 16s. net.

Sewerage: The Designing, Construction, and Maintenance of Sewerage Systems. By A. Prescott Folwell. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898. Price 3 dols.

The Designing of Draw Spans. In two parts. Part I., Plate Girder Draws. Part II., Riveted Truss and Pin-connected Long Span Draws. By Charles H. Wright, M. Am. Soc. C.E. First edition. First thousand. New York: John Wiley and Sons. London: Chapman and Hall, Limited. 1898. Price 3.50 dols.

TRANSFERENCE OF HEAT IN COOLED METALS.

THE following letter is taken from *Nature*. Little as physiological observations are to be trusted, as a rule, we cannot help thinking that the transference of heat in cooled bars is too well and widely experienced for the illusion to have been as complete as Mr. Kinsley's letter would make out:—

Several observers have noticed a rise of temperature at the cooler end of a bar of metal when the hot end was suddenly cooled. As this would be a most surprising effect, and as the John Hopkins University has been mentioned in connection with the subject, Dr. H. A. Rowland has requested me to examine the matter.

Iron and steel bars of about one-half inch diameter were used, and iron-copper thermo-electric couples were soldered to the cooler end and the side. A reflecting galvanometer was used that gave a deflection of 1 mm. per 0·05 deg. Cent. The end of the bar was heated by a Bunsen compound burner, or in a muzzle furnace with a blast lamp. The hot end of the bar was cooled either with blocks of ice or by plunging into ice water.

After errors due to jarring the galvanometer, and to changes in the magnetic field of the galvanometer caused by motion of the bar, had been eliminated, even under the most trying conditions no effect was observed. The temperature of the cooler portion of the bar did not increase when the hot end was suddenly quenched.

The most severe test imposed included the sudden quenching in ice water of the end of the bar, 3in. of which was above the red heat. The thermo-couple then was only 9in. from the glowing end of the bar.

The galvanometer, of course, showed the usual slow change of temperature due to conduction. There was then a comparatively long time after quenching before any change of temperature was indicated, and then the change was only a reduction of temperature.

CARL KINSLEY.

John Hopkins University Physical Laboratory,
Baltimore, U.S.A., December 9th.

CATALOGUES.

JOHN SWAIN AND SON, Limited, London. Specimen books of wood and zinco engravings. Readers of this paper are already familiar with the excellence of Messrs. Swain's productions.

Baldwin Locomotive Works, Burnham, Williams, and Co., Philadelphia, Pa., U.S.A. Part IX. of this enterprising company's "Record of Recent Construction," contains thirty-two pages of illustrations and particulars of locomotives turned out recently.

BARRY DOCKS.—In our list of names of engineers engaged on the Barry Dock works, we omitted to mention Mr. A. Havelock Case, M.I.C.E., who was resident engineer under Sir John Jackson for the construction of the deep sea lock, illustrated on page 583, from March, 1893, to February, 1895.

MANCHESTER SEWERAGE.—At a recent meeting of the Rivers Committee of the Manchester City Council the preliminary report of the sewage experts appointed by the Council last spring was read. The report, which was signed by Messrs. Baldwin Latham, Percy F. Frankland, and W. H. Perkin, jun., stated that since entering upon this inquiry in June last, the experts have not only visited a number of sewage works presenting features of novelty in different parts of the country, but have also instituted experiments of their own with a view to determining the best mode of dealing with the sewage of Manchester, so as to obtain an effluent of sufficient purity to comply with the requirements of the Mersey and Irwell Joint Committee. The inquiry has already reached such a stage that they are able to say without hesitation that from the results obtained with the double contact beds constructed according to their instructions at Davyhulme by the city surveyor, and the experiments carried on by the experts, which have been directed to the treatment and purification of settled and crude sewage without the use of any chemicals, they are of opinion that the bacteriological system, notwithstanding the particular nature of the Manchester sewage, will purify that sewage and will yield an effluent which will comply with all the requirements of the Mersey and Irwell Joint Committee, and which, when discharged into the Manchester Ship Canal, will be the means of greatly improving the waters of the latter.

THE MEXICAN MACHINERY MARKET.

THE recently-published consular report on the British export trade to Mexico contains much which should be of interest, if only for the hints it gives for the use of British manufacturers as to the methods they should adopt in approaching the Mexican market. The Mexican purchaser will take no more trouble than he can avoid, and rather than do so he will frequently take an inferior article if it is put before him in a tempting way; or, as the consular report has it, "according as the conditions of delivery, payment, &c., are adjusted to suit his convenience." Now, the British manufacturer does not seem to have fully recognised this point. He has not hitherto considered it worth while to make much effort to capture the Mexican market, and yet it would appear that he would derive benefit from so doing. The trade of the country has greatly increased of late years, and there is every appearance of further development. A hard struggle is likely to ensue, however, for the markets are in few hands, and these are mostly German, French, or Swiss. Further than this, the transit of goods from the United States has been so greatly facilitated that goods can at present be delivered in a considerably shorter time than is at present the case from the British Islands. Still the Consul seems to think that with tact and perseverance a good opening is available. The first consideration, without doubt, is to suit the article to the consumer. Now Britain is notoriously bad in this direction, but she is improving, and will no doubt continue to do so. It is beyond doubt necessary to have a competent agent upon the spot—a man thoroughly acquainted with the natives and their language—and not only that, but a man who is capable of obtaining and keeping the friendship of the people. Stress is laid upon this since a large proportion of Mexican trade is done by means of personal friendships. Such a man, though difficult to obtain, should certainly be forthcoming, but, of course, he would be an expensive man, and a very useful suggestion is given, namely, that should one single firm find the expense too great, two or more should combine to employ one man at a single point and allow him to appoint his sub-agents. A smart man of business, having a complete knowledge of the goods which he is trying to sell, would be a necessity. Especially is this the case with machinery. A too-detailed description in a catalogue might give clues to competing firms, and to supplement what is ordinarily given, a man who knows his work thoroughly is a *sine qud non*. Catalogues should be printed in the Mexican dialect; much delay will be avoided in this way by reason of the purchaser understanding what he is buying. Promptness in the execution of orders is also an absolute essential, so as to compete with the United States, for example; and much greater care than has hitherto been given to this branch must be taken in packing. Goods frequently arrive damaged, and are not packed so as to reduce freight charges to a minimum. Cheapness must be aimed at, but cheapness combined with extra finish, and there is a demand for a very light class of machinery which is easy of transport. The Consul's concluding statement strikes the right note—it is hopeful, and yet imposes a condition. He says that it may safely be affirmed that there is no reason why British trade should not hold its own in the Mexican market as against foreign competition, if manufacturers and agents would really exert themselves in the matter.

This is what is required if a good trade connection is to be made, and nowadays it is of the utmost importance that advantage should be taken of openings everywhere. We hear a great deal of trade being lost in various places. Why not endeavour to step in and make up for it in other directions?

ON Christmas Eve, Mr. Jardine, the engineer of Nottingham, and Mrs. Jardine entertained in the Meadows Hall, about 750 of the children of the work-people employed in Mr. Jardine's various factories. The cinematograph, showing a large number of very interesting and amusing living pictures, was exhibited, and Jardine's military and drum-and-fife bands were in attendance. The children were each presented with a piece of new silver money, and other souvenirs of the occasion.

DRILLING MACHINE.

THE principal feature about the drilling machine illustrated by the accompanying cuts is Humpage's patent internal gear, shown in section in Fig. 2, and in perspective elevation by Fig. 3. There is also shown in Fig. 4 a general view of a lathe head fitted with it. The drilling machine has a swing of 20in., the distance from the centre of column to the centre of the table being 10in. The traverse of the spindle is 8in., and its diameter 1¼in. The total weight is 7¼ cwt. It is made by Messrs. Humpage, Jacques, and Pedersen, of Ashton-gate, Bristol, and possesses several commendable points which will appeal at once to users. In the first place it is entirely self-contained; secondly, the hand-feed is controlled by the large cross arm levers, so that both feed and return can be made rapidly, whilst a three-speed cone with worm and wheel, thrown into gear by a clutch, is provided for power feeding; thirdly, the belt shifter for fast and loose pulley is controlled by the foot of the manipulator, leaving both hands free; and fourthly, the feed rack is graduated in eighths of an inch, to indicate the vertical travel of the drill. It is also worthy of notice that the gearing—which, by the way, is all machine cut—is for the most part enclosed. With regard to the patent gear, the following description read in connection with Fig. 2 should make its action clear:—

Fig. 1—MESSRS. HUMPAGE, JACQUES, AND PEDERSEN'S DRILLING MACHINE

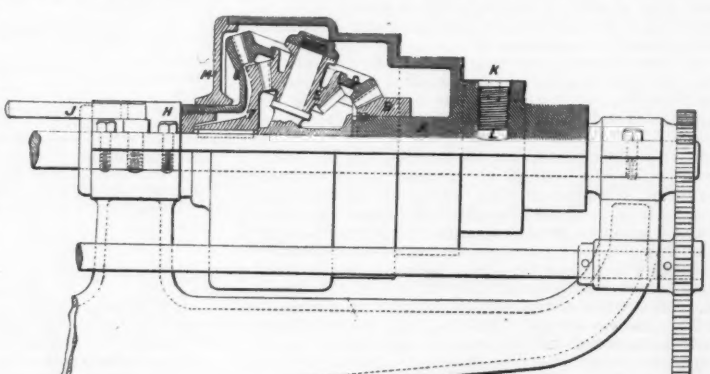


Fig. 2—SECTION OF HUMPAGE'S GEAR

The cone pulley is made with an internal boss A, to which is fastened the first driving pinion B. A double-armed cross-head, which is free to rotate on the mandril, carries on each arm a pair of wheels D and E, which are fastened together and rotate as one. The wheel F is keyed to the mandril, and the wheel G is provided with an extended boss which fits in the split-bearing H, and can be gripped and prevented from turning by tightening the handle J. The second pair of wheels D^1 E^1 are carried on the crosshead arm at an angle of 180 deg., and cannot be seen in the half section drawing, but are shown in Fig. 3; in some instances a balance weight is substituted for this second pair of wheels.

The action of the gearing is as follows:—The wheel B gears with D, which in turn gears with G, and the wheel E gears with F. On turning A, the wheel B drives D, and as G is fixed and cannot revolve, the wheels D E and the crosshead C are caused to rotate bodily around the mandril, at the same time the wheels D E run on the arms of the crosshead. This compound movement of D E of rotation on their own axis, and also bodily around the mandril, causes the wheel F to be driven in the same direction at a pre-determined speed according to the ratio of the gearing.

When it is desired to run in single speed the screw K is tightened against the mandril through the gun-metal pad L, and the handle J is slackened. The whole gear is then locked together, and turns without teeth being exchanged. The end plate M forms an oil-tight joint, and all the wheels run in a bath of oil. The number of teeth in the gear in question are—

B = 12	F = 34
D = 40	G = 46
E = 16	

Ratio 10·53 to 1.

The advantages obtained by the use of this gear, which is equally applicable to lathes, milling machines, &c., are:—

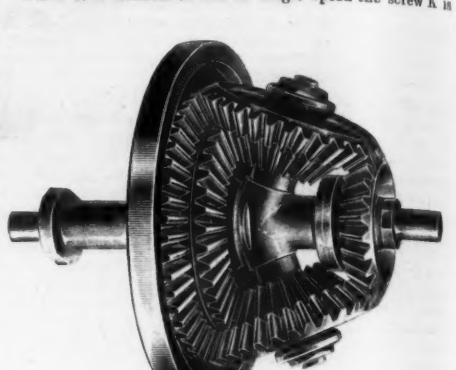


Fig. 3—DRILL HEAD GEAR

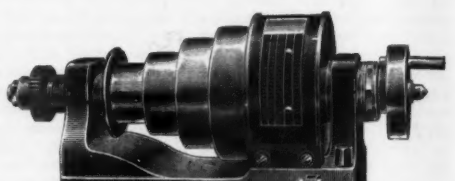


Fig. 4—LATHE HEAD

The whole of the gearing is cased in and protected from dirt and dust, and the wheels running constantly in an oil bath, perfect lubrication is assured, and wear and friction are very much reduced. The arrangement is more compact than ordinary back gear, and efficient protection is afforded to those working the machine. Owing to the balanced double drive all side strain on the mandril is taken off, and there is no tendency to bend it, as is the case with ordinary back gear. As the drive is taken at two points on the wheel F, the strain is halved and teeth of a smaller pitch may be used. The ratio of the gearing can be varied to a very large extent with but a small alteration of the wheels themselves, *e.g.*, by adding four teeth to the wheel E the ratio of the gearing is increased from 10·53 to 1 to 14·93 to 1. The changes from single to double, and *vice versâ*, can be quickly and easily effected.

DYNAMOMETER CAR.

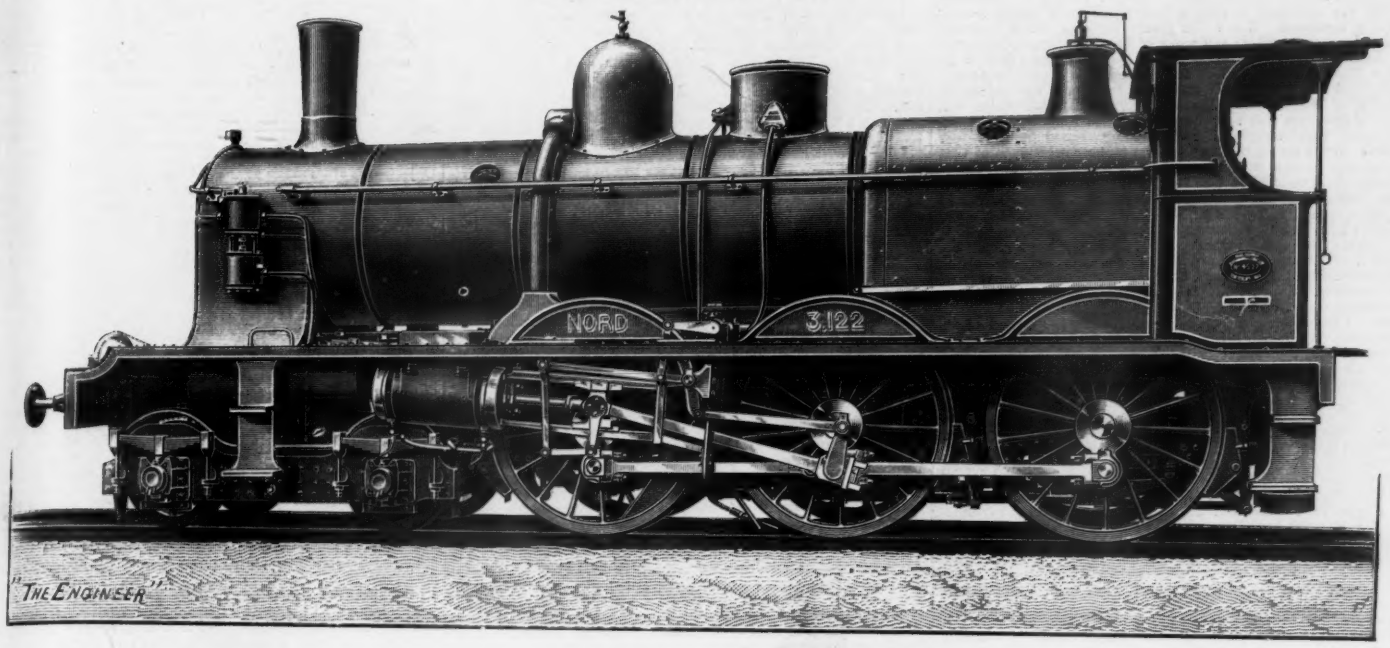
THE engineering departments of the large American universities are giving particular attention to the practical education of their students, and through the co-operation of Mr. Barnard, general manager of the Big Four Railroad, and Professor Breckenridge, head of the department of mechanical engineering at the University of Illinois, a new dynamometer car has just been built by the railroad and equipped by the University, to be used for the mutual advantage of both parties. The car was built at the railway shops, and the apparatus was installed by Assistant Professor Van Dervoort, of the mechanical engineering department.

Several runs have already been made, and there is good reason to believe that much valuable information will be gained from its use. The car is 36ft. long, and weighs 36,000 lb. It is neatly finished inside, and arranged for comfort and safety. The objects sought in the design of this car were twofold—first, to provide more satisfactory and safer means of making locomotive road tests than when all the observations are made from the locomotive itself; secondly, to provide suitable automatic apparatus for recording the pull on the draw-bar of the locomotive. By mounting a considerable number of the instruments in the car the changing of these instruments from one locomotive to another is avoided, and they can be more carefully mounted and more accurately read.

The records, which are automatically recorded on suitable charts, are:—(*a*) Boiler pressure; (*b*) speed in miles per hour; (*c*) pounds pull on the draw-bar: (*d*) time on passing mile-posts. The records, which are recorded by observations

COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD

M. DE GLEHN, ALSACE, ENGINEER



from instruments mounted in the car, are :—(*e*) Steam chest pressure; (*f*) pounds of water delivered to boiler; (*g*) revolutions of drivers per minute; (*h*) air pressure in auxiliary reservoir; (*i*) air pressure in train pipe. The car is to be supplied with a switchboard and a complete set of signal-bells, and arrangements are being perfected for recording on a special chart many other observations not included in the above lists, such as :—(*j*) Time of taking indicator diagrams; (*k*) position of reversing lever; (*l*) position of regulator; (*m*) temperature of escaping gases; (*n*) bags of coal delivered to fireman; (*o*) direction of wind; and (*p*) velocity of wind. This will leave but few observations to be taken directly by individuals, and requiring not more than three men on a locomotive during a test, *i.e.*, two at the indicator, and one in the cab at the calorimeter.

The Boyer speed recorder is driven in the usual manner from the axle of the car, while the drum of the recording gauge is also driven from the same connection, the clockwork having been removed, and suitable gearing interposed. On this drum is recorded the tension on the draw-bar. The dynamometer cylinder is 8in. in diameter, and the piston and piston-rod are packed with cup and U leathers respectively. The cylinder is filled in front of the piston with oil, so that the pull on the draw-bar is taken by the oil, and the pressure per square inch recorded by the gauge. The recording gauge is graduated to 1000 lb. The drum is about 5in. in diameter, and rotates at different speeds depending upon the gears used; 6in. per mile is the fastest rate that has been used. The second hydraulic gauge which is attached to the same pipe is graduated so as to indicate the total tons pull on the draw-bar. When the car is not in use, the oil is stored in the oil tank in the upper part of the car. It can be pumped into the dynamometer cylinder by the pump, and it can be raised again into the tank by allowing air from the brake reservoir to enter the cylinder from above. Any oil leaking past the piston can also be raised into the tank in the same way.

When the oil is discharged from in front of the piston the pull on the draw-bar is taken on the draw springs as usual, the piston moving nearer the front of the cylinder. Under no conditions can the piston strike either cylinder head. The variation of the recording pen during a recent pulling test was not over 5 lb. at speeds above twelve miles per hour. For slower speeds there was more variation, corresponding to the actual conditions, while at the lowest speeds the revolutions of the engine could be counted on the diagram. A change in the position of the reversing lever or regulator makes a noticeable change in the diagram.

FRENCH LOCOMOTIVES.

THROUGH the courtesy of M. de Glehn, Administrateur-Director of the Société Alsacienne de Constructions Mecaniques, we are now able to give an illustration of the splendid ten-wheeled engines designed and constructed by him on the four-cylinder compound system, and adopted for the service of the Chemin de Fer du Nord by M. du Bousquet, the very able Ingénieur-in-chef du Matériel et de la Traction of that progressive railway. Fifty of these engines are already at work on that line, and the type has been largely adopted on the Est and other leading French railways.

The principal dimensions of these engines are as follow:—Diameter of high-pressure cylinders, two, placed outside, 13·8in.; of low-pressure cylinders, two, placed inside, 21·6in.; length of piston stroke, 25·2in.; diameter of coupled wheels, six, 5ft. 8·7in.; heating surface tubes, 1828 square feet; fire-box, 122 square feet; total, 1950 square feet; grate area, 24·4 square feet; steam pressure, 213 lb.; weight of engine in working order, 58 tons 12 cwt.; adhesion weight, 42 tons 9 cwt.; weight of six-wheeled tender loaded, 35 tons 7 cwt.; total weight of engine and tender, 93 tons 18 cwt.

In Mr. Rous-Marten's last article—ENGINEER, November 18th, page 488—he gave particulars of a remarkable performance by one of these engines, which, taking a load of 340 tons exclusive of engine and tender—the total including engine and tender being 433 tons—started from a signal stop on a rising gradient at 1 in 200 which continued for 10 miles; attained 40 miles an hour in 2 miles, and then maintained 47 miles an hour steadily to the summit; subsequently maintaining 51 miles an hour up a long ascent at 1 in 250 and 52 up 1 in 300 with that heavy load. Running downhill, a speed of 65 to 68 miles an hour was kept up very easily and smoothly. The total run of 71¼ miles from start to stop, 32 miles of the distance being on an up grade mostly at 1 in 200 and 1 in 250, was done in 81 min. 47 sec. running time, or 79 min. 32 sec. net, with 340 tons behind the tender. On the return journey, with a train of 201 tons a speed of 73 miles an hour was sustained for some miles. It will be admitted by all who are competent to judge that these figures represent very fine all-round locomotive work. Several specimens of performances by these engines will be found on pages 101 and 488 of the current volume of THE ENGINEER.

LETTERS TO THE EDITOR.

(*We do not hold ourselves responsible for the opinions of our correspondents.*)

BRITISH AND AMERICAN MACHINE TOOLS.

SIR,—My letter to you on the above subject has called forth a considerable number of letters, many of them sent to myself privately. With due deference to these gentlemen who have favoured us with their views, they have not written anything to shake the statements made in my first letter. They take up small points, and these fill their minds, to such an extent that the large and important question of how the British tool-makers are going to recover their lost ground and prevent more ground being taken from them by the Americans, is, and has been, entirely lost sight of. This is a question which I am sure cannot but be a momentous one to any toolmaker who wishes to see the supremacy of British manufactures maintained not only at home, but also abroad.

"Anglo-Saxon" asks me where I have gained my knowledge of American machinery—from actual use, from catalogues, or from travellers for American machinery. I may inform him that my opinion has been gained by actual use myself, and through the experience of others who have used American machinery. For some years my firm has had American machinery at work, and it has given us so much satisfaction that I have had no hesitation in ordering from time to time a considerable quantity more. Your readers will understand when I say that my firm has spent and is spending a good few thousands of pounds in American machinery, that I have some right to speak on the subject. "British Toolmaker" thinks that I have been burying my head in Halifax, and asks me to visit some of the leading shops, marine and otherwise, and get acquainted there with British design and manufacture. I may inform him that I have not lived all my life in Halifax. I served my apprenticeship with one of the leading marine engineering works on the Clyde, and worked as journeyman for one or two firms in the same neighbourhood, and I daresay I know as much, if not more, of the machinery in these places as does "British Toolmaker." Moreover, I have not lost opportunities since that time in making myself acquainted with British tools during the travels which any business man has to make on business, both in this country and abroad.

Mr. Hodgson will need very little reply from me. I have heard these stories of American machines not turning out the quantities of work stated. I have also heard stories of the same nature as that of the broken stamping press. Such things are unavoidable, in my opinion, where foreign machinery is put in the hands of people, workmen and others, who will not make the most and the best use of them. A great deal depends on the personal element of the users of machinery. Any engineer, no matter what department he may be in, finds this to be a matter of fact. However, I can, from my own experience, adopt the same argument about British-made tools, and justify it by reference to milling machines which were stated not to chatter when taking certain cuts at certain speeds. Again, I know of capstan lathes, of their incapacity of doing the work stated, and with which the makers' own experienced workman failed to come near to the quantity guaranteed; of horizontal boring machines, which were stated to be able to bore holes truly round and parallel, and which failed to do so until altered by ourselves—these tools, it must be understood, were not made by gim-crack makers, but were high-priced tools by good firms. However, such accidents or difficulties as these do not affect the question of which I write about. They are mere side issues. That the Americans build splendid tools, having many labour-saving devices over British tools, and that they have an enormous sale both in this country and on the Continent cannot be denied, and it would be well for British tool-makers to read, mark, learn, and inwardly digest this.

Mr. Hodgson gives good advice when he says that our tool makers do not get up good enough catalogues. I have before me a catalogue of tools issued by a Manchester firm having a deservedly good reputation for their machines. Their catalogue would disgrace a second-hand shop in a back street, and I am sure it is a drawback rather than a help to them. Another point in which English catalogues fail is that they do not give enough detailed information regarding their machines. To illustrate what I mean, I will suppose that I wish to buy a lathe. I go to an American catalogue, and find there an illustration showing the machine I want. The letterpress gives me the greatest diameter the lathe will turn over the bed, the greatest diameter it will turn over the carriage, the greatest length it will take between the centres, the exact diameter of each of the cones and width of the same, the power of the gearing, the number of changes of feed, and the net and gross weights, and the cubical measurement of the lathe boxed. There are few English catalogues indeed which give you detailed information such as this, and which is necessary to enable a busy man to come to a decision about any machine that he requires.

In my last letter I wrote about several kinds of tools which could not be purchased at all in this country, or if they could be purchased they were much behind in speed, capacity, and design. Only two kinds of machines are really dealt with by your correspondents, namely, planing and horizontal boring machines. It will be readily understood by your readers that my previous letter dealt with the standard practice of British and American tool-makers. I do not profess to have a knowledge of all the details which every toolmaker puts into his machine. It is impossible, even for the toolmaker himself, to know all the different points in machines of all kinds that are made in this country. I therefore referred to what was the standard practice. It will be best for me, in reply to your correspondents, to go into detail on some of the machines referred to.

As to lathes. In my last letter I made a statement that you could only buy a lathe from one or two firms in this country—Messrs. Langs, of Johnstone, being mentioned by me—which had a handle feed motion on the back shaft, whereby the use of change wheels for altering the feed was not necessary, and I stated that these lathes could only be bought, with this improvement on, a few years ago. Mr. Lang, however, informs me that he has made his lathes with this addition for over twelve years. In making this correction, I wish to point out that this is an illustration of the conservatism and slowness of the British toolmaker in adopting such a splendid improvement in lathes as I have mentioned. Mr. Lang has been making these lathes for a considerable number of years, and the other British toolmakers have not thought it worth their while to adopt this improvement. A lathe with such an addition can be bought from any respectable maker in the States. "British Toolmaker," like all our other lathe makers, puts flanges on the cones to prevent the belt getting into the back gear wheels. Unless this cone is much larger in diameter than is usually put on, the belt does get into the wheels; the American method is by far the simplest and the most effective. Why are the other points that I mentioned about lathes ignored? I spoke of permanent gear for cutting screw threads and automatic stops, &c.

As to vertical drilling machines. "British Toolmaker" tells me that the arrangement of movable head on these machines was adopted by his firm some years ago, and that it is only of late that this plan has been favourably received by users. The question as to whether these drilling machines with movable heads has only been favourably recognised by users lately I leave aside, but the confession which he makes is not a satisfactory one to his firm. It does not show any energy or capacity for bringing this improvement in drilling machines before the British public—presuming, of course, that his machine is a good one. The advantages of these drilling machines have been brought prominently before the users of machinery by the Americans, and it is by such methods that the Americans have gained the market that they have. They have put these machines, with all their labour-saving devices, right under the very noses of the users, and compelled them to look, and when they have looked and seen that they have a number of advantages attached to them, they have purchased them. I am afraid that this drilling machine of "British Toolmaker" has been kept in his own works, and only those who went there knew anything of it. Movable heads in the American drilling machines are not the only point which I referred to. I referred to the fact that the double gear in the American machines can be thrown in and out of gear while the machine was at work. Also that they were in all cases fitted with automatic stops to the feed, and that great ranges of feed were given in the American machines. I have still to see an English machine with these points.

Next, as to boring and turning mills, I may tell "British Toolmaker" and a "Fitter" that my remarks concerning these do not refer to their origin or ancient history, but referred to present-day affairs. I stated that they could only be purchased from one or two firms in this country, and that they had only recently been pushed by these firms. "British Toolmaker" may have made them for half a century, but they had not made any headway with them until the Americans came along and made a market. Where 'British Toolmaker" has sold one the Americans have sold hundreds. It would also seem that "British Toolmaker" has altered his patterns *very little* since he started making these machines. What can anyone make of the methods of "British Toolmaker" from the confession of one that they have been making these machines for half a century? How is it, then, that the American machines have been the most adopted?

Turning to planing machines. Can the managing director of Messrs. Sharp, Stewart, and Co., Limited, or "British Toolmaker" affirm that broad feeds are the standard practice of British-made planes? It cannot be affirmed by either of these gentlemen that such is the case. "British Toolmaker" carefully avoids the question of cutting and quick-return speeds on his planing machines. Why? In return he asks me if I would recommend such speeds as I speak of for large planing machines for dealing with armour plates. No, I certainly would not. I am not so foolish. I wrote about tools suited for a general engineer's shop, and not for an armour-plate factory. The managing director of Messrs. Sharp, Stewart, and Co. manfully states that their planes have not such quick speeds as American machines. He says that their standard cutting speed is 22ft. per minute, with a return speed of 3 to 1, and he candidly states that this is high enough for him. With due deference I beg to say that it cannot be good enough for him or any other man, especially when they can get machines to turn out splendid work, and do it at a quicker speed. I may tell Mr. Robinson that I have seen a planing machine 14ft. long by 4ft. wide by 4ft. high cut at a rate of 25ft. per minute, and with a return speed of 100ft. per minute, and this without any shock at the reversing. I certainly never expected to see a representative of Messrs. Sharp, Stewart, and Co. write that 66ft. was a quick enough return speed on planing machines, when Americans can offer and sell the same machine to do it at a faster speed. I am aware the increased speed is only a question of arrangement. Of course it is, but this arrangement never seems to get worked out by the British tool maker.

As to horizontal boring machines, I stated in my last letter that the American machines of this class which my firm had ordered cost us £240. I find in the hurry of writing that this was an error, and on examination find that it was only £210. "Anglo-Saxon" says that as I did not purchase the British boring machine how can I speak with authority about it. I reply that I made full inquiries from those who had similar machines at work. Further, that we have in our own works, made by the same firm, a horizontal boring machine, though this machine is not exactly of the same type, yet our use of it has enabled us to speak with authority. I shall not have the slightest hesitation in giving my experience after six months' work with these American machines. I will, Mr. Editor, with your permission, do this at some future time, when I can have the two machines tested together, *i.e.*, the British and American, doing the same class of work, and I shall be pleased to see "Anglo-Saxon" if he wishes to come to our works to see the trial made. I am afraid, however, that the result of the test will not be satisfactory to "Anglo-Saxon." "British Toolmaker" has sneered at the price of American boring machines, and talks about better workmanship and design and quality of material in the British-made tools. All I can say is that the American machines will bear the closest comparison with any similar machine which has been produced in England. The capacity of the American boring machines purchased by us is 18in. diameter by 48in. long.

As I stated at the commencement of this letter, there are several things which my critics have not touched upon. I would like to ask which firm in this country is going to be the first to make a full line of automatic gear-cutting machines; which firm in this country is going to be the first to make a full line of keyway-cutting machines; which firm in this country is going to be the first to make heavy turret lathes to deal with bars and castings; which firm in this country is going to be the first to make a tool-grinding machine, such as the Sellers and Gisholt, for grinding lathe, planing, and shaping machine tools? None of these machines, and others could be mentioned as well, are practically made in this country.

There are other departments in toolmaking which British firms seem to have lost all hope of ever recovering, or if they compete with the Americans, do so in a small and spasmodic manner. I refer to the manufacture of milling cutters for gear wheels and other kinds, twist drills, reamers, chucking reamers, and measuring instruments.

I am loth to take up more of your space with a longer letter dealing with this matter, but I would like to say a little in reply to Mr. Coventry's letter.

I am sorry that Mr. Coventry has introduced the personal element into this discussion. In writing my first letter I had no personal end in view, nor did I wish to vent any feelings of my own against Mr. Coventry's firm or any other firm of British tool makers. Mr. Coventry confirms my statement that his firm could not deliver the keyway cutting machine under six months, and that they exceeded even this long date. He complains, or tries to insinuate, that the fault was partly due to ourselves in not ordering the cutters sooner. I am aware that there was delay in ordering these, but when the machine itself was not finished in seven months from date of order, my firm were quite justified in cancelling the order. Mr. Coventry does not attempt to deal with the essential facts about keyway cutting machines, viz.:—That only one firm in this country makes these machines; that it is an American patent and not a product of British ingenuity; that the tools for an average range of work cost more than the machine; that several American machines can be purchased at less than half the British machine, and they are guaranteed to cut either cast iron, wrought iron, or steel, and the same tools which cut parallel keyways can be used to cut taper ones.

I accept Mr. Coventry's correction as to the date when his firm began the manufacture of boring and turning mills. My opinion remains the same respecting the British-made machines. They are not up to date in design and speed in producing work.

"British Toolmaker" and others seem to think that for these machines all that is required is a resurrection of some old planing machine patterns, and to re-arrange them to make the whole into a boring and turning mill. I see in one of your contemporaries an illustration of a Manchester-made machine of this type, a couple of old planing machine standards with straight backs are used, and a planing machine cross slide put over them. Straight back standards either for boring and turning mills or planing machines are somewhat ancient now-a-days.

Mr. Coventry's attempt to deal with capstan lathes is, in my opinion, quite ludicrous. If there is one branch of toolmaking wherein British makers fail it is in this line.

I reply to Mr. Coventry, and tell him that I am fully aware of the capstan lathes made by his firm and Messrs. Muir's, but they are not to be compared with the Herbert or American tools. I speak with some experience; my firm has used a Smith and Coventry capstan lathe for a few years. It is a good, sound, honest machine, but is woefully behind the others in output. All British capstan lathes are alike in this respect, and will be until they make their standard patterns to have automatic revolving capstans or turrets, screwing dies to open and close automatically, have the turrets in direct line with the lathe spindle, and the lathe arranged with automatic or wire feed, so that it need not be stopped while the work is being moved along. These are a few points only our toolmakers fail in touching the American turret lathe. My own opinion is that if any responsible person should purchase a British capstan lathe, knowing the increased capacity and production of the American machine, I should consider him to be slightly foolish.

Mr. Coventry is good enough to inform your readers that he has two American drill presses to dispose of, because they are not capable of comparison with British tools of smaller dimensions. I am sorry Mr. Coventry has had such a bad experience, but I wish to point out that he is not an impartial judge, and I therefore do not accept his statements till further informed. Are we to understand, then, that Mr. Coventry believes the American drill with movable head, balanced head and spindle, with fast and slow hand feed, wide range of power feed, automatic stops to the feed, graduated spindles, &c., are a failure, or that the machine is designed on wrong lines? I infer these to be Mr. Coventry's opinions. If I am correct, I am sorry for him, and if British toolmakers generally have these opinions or prejudices, then there can be no hope of real advancement until young firms spring up determined to make headway, even though they have firms of great renown to fight against.

In my last letter I incidentally mentioned the adaptability and quickness shown in altering patterns by the Americans, so as to improve weak points in their tools. I mentioned this in connection with their lathes, and told the British makers that they should not reckon on this lasting. I was not aware at that time that the American toolmaker had increased the proportions of the driving gear, tool rests, &c., and found this out upon a recent inspection of some American lathes in London, the result of which was that I bought my first American lathe. This will give our toolmakers an idea as to what is going on constantly.

I hope, Mr. Editor, that this letter will not prove too long for your columns. I have only to say again that I have no desire to "puff" American tools, and I only write this letter to bring before the British toolmakers the true state of things of what is going on round about them.

HUGH CAMPBELL.

Gas and Oil Engine Works, Halifax,
December 27th.

SIR,—The letter of Mr. Hugh Campbell has drawn attention to this important subject, and I trust that you will keep your columns open in order that the matter may be thoroughly thrashed out, dealing as it does with the very foundation of our engineering and commercial prosperity. The question has naturally two sides, the machine tool maker's and the machine tool buyer's. Mr. Campbell made some statements that were not quite correct, and thus laid himself open to criticism and correction. Nevertheless there was much in his letter that would be difficult to controvert, and it is very evident that his attitude on the general question does not represent a solitary instance, but is shared by a very considerable number of tool buyers and users.

Rightly or wrongly, the belief is gradually gaining ground that American tools are superior to those of British make in accuracy, handiness, and output. If this impression is an erroneous one, if it is based on ignorance of the merits of British tools, then the British toolmakers have only themselves to blame. If their tools are equal or superior to American tools, let them advertise their merits in a proper way, and not continue to hide their light under a bushel. Their former supremacy is now gone, or, at all events, very seriously challenged, and they must abandon their attitude of proud reserve and adopt a different system of advertising. When a buyer is in want of a machine, American makers, or their British representatives, furnish him with illustrations and detailed descriptions of their machine in which the special features of the design are fully explained and descanted on. In many cases illustrations of pieces made by the machine are shown, and the time taken to finish each, or the output per hour is stated. This output is guaranteed, nor is the guarantee always valueless—*pace* some of your correspondents—since the makers will send a man to purchaser's works to prove it by actual demonstration. Granted that this is in the nature of a "trial trip" under the best possible conditions, it is at least something to go upon, an ideal to be striven for. The foreman then knows of what the machine is capable, and is in a better position to detect the lazy or incompetent workman, or to checkmate the manœuvres of the trade union "shop steward."

Contrasted with this, the attitude of the British maker is almost one of indifference. He says nothing whatever about output, and if his design of machine has any particular merits, the buyer has to put himself to a good deal of trouble to find them out. They are not detailed ready to his hand. He is a busy man, and has no time to make the necessary investigations. No wonder, then, that in so many cases he accepts what he find so ready to his hand, and the American toolmaker scoops in another order—and deserves it too.

When we take the machines themselves, I do not think that anyone can question the superiority of the American type as regards convenience of manipulation—in a word, handiness. There are, in my opinion, two causes for this. The first is the extensive adoption of the piecework system in the States. Machinists paid by the piece soon discover the features that make for a larger output and bigger wages, and if a machine is not easy to handle, the manager soon hears about it. This re-acts on the toolmaker, who finds it to his interest to devote a very great deal of time and ingenuity to perfecting this feature.

In some shops on this side the leading draughtsman designs the general body and gearing of the machine, then the drawing is handed over to an apprentice in his second or third year to "fill in" the levers, feed handles, &c. Thus it comes that too many machines look as if these most vital details had been stuck on as a mere after-thought.

The second cause is to be found in specialisation. American firms frequently confine themselves to a few designs, and turn these out in large numbers, so that they have a better opportunity of eliminating any faults, and of perfecting the various details.

The next feature I have mentioned is accuracy. I cannot speak with authority on this point. My opinions might be classed with those of the "man in the street," and are simply impressions based on what I have read in English and American trade journals and makers' catalogues. But they are thus more likely to represent the opinions of the average buyer. The first thing that strikes one is the common use of micrometer gauges and measuring machines in American shops. Quite a number of firms make these gauges a speciality. A few shops on this side may use them, but they seem to be the exception and not the rule, and I have never seen a single British firm advertising themselves as makers of micrometer gauges. This speaks of the limited demand. I admit, of course, that the use of these gauges is not an infallible proof of good workmanship in every case, but it shows a more scientific method, and one likely to yield better results with equal degrees of skill. On this side we depend on the skill of the turner for the excellence of fit, say, of a shaft in its bearing, and of a keyed wheel on its shaft. A different diameter is required in each case, but how many British workmen could give the difference in size a name? In shops where wheels are forced on their shafts by hydraulic pressure, *e.g.*, railway wagon wheels, the skilled workman can tell by the "feel" of his calipers just what fit will require a pressure of, say, 50 tons to force the wheel on; but not one in a thousand could name the minute fraction of an inch that represents the actual difference in diameter between the wheel and its axle.

As a contrast to this state of affairs, we are told that in such shops as Brown and Sharpe's, Pratt and Whitney's, and others, the men ordinarily speak of "a half" or "a quarter," meaning, not half an inch, or a quarter of an inch, but a half-thousandth or a quarter-thousandth of an inch; so accustomed are they to gauging their work to these fine measurements. As proof, too, of their general use, an American paper recently presented its readers with a supplement—a card intended for every-day use in the workshop—showing by diagram the required clearances in thousandths of an inch for running fits, tight fits, and force fits respectively on any diameter of shaft.

A common feature on good American tools is the micrometer index on every feed screw. No first-class machine is considered complete without it. Now, I shall not go so far as to aver that no British-made machine is ever fitted with this attachment. But I have never seen one myself, and may safely say it is very far from common.

Again, American tool-makers will tell you within what limits of accuracy their workmen are constrained to keep, and they will guarantee that a machine, a lathe, *e.g.*, will have the alignment of driving spindle, tail stock, bed, cross-slide, &c., true within a certain specified limit. If British toolmakers adopt the same methods in shop practice, and are prepared to guarantee the accuracy of their ordinary machines within a specified limit, then why don't they advertise the fact in your pages and those of your contemporaries, and in their own catalogues as well? As far as my own observation and knowledge goes, such a guarantee is never offered, and buyers cannot be blamed if they conclude that the guarantee is not given because the machine would not bear the necessary test.

There is no material difference between the picture of a cheap Yorkshire tool and the picture of the same size machine by a first-class firm. The specifications of both contain the same vague generalities about "first-class materials and workmanship." Apart from the prices and the reputation of the firms, there is nothing to guide the buyer. To the uninitiated one machine is as good as the other. Now, if the good maker would put in his specification an additional clause stating the limit of error in alignment, &c., within which he would guarantee his machine, he would give the intending purchaser something tangible to go upon, instead of relying, as he seems to do now, almost entirely upon the prestige of his name. Objection is often taken to the lightness of American machines as compared with the usual massive design of British tools. Where the lightness is such as to lead to excessive distortion of the parts under working stresses, or to excessive wear, and consequent loss of accuracy, then it is to be condemned. But, on the other hand, massiveness may be mere clumsiness. It is only a truism to say that excess either on the side of lightness or weight is bad design.

Machine tools, I think, should be designed and built to last for about ten years, and retain their accuracy for that period with a reasonable amount of up-keep. After that they should be flung out and replaced by others of the latest design. This means writing off 10 per cent. of the original cost of the machine each year for depreciation—a very unusual practice, but the only one on which continued prosperity can be based. The backward condition of many British shops at this day is due to the fact that tools purchased twenty-five years ago are still in good working order. The owner grudges to throw them out, and as, at most, only 5 per cent. of the reduced value has been written off each year, they still stand at a considerable figure in his books. The policy I advocate, if put into general practice, would soon make itself felt in the improvement of tool design through the impetus it would give to the tool trade and the increased demand for the most up-to-date machines.

In conclusion, I think Mr. Theodore Coventry is wrong in assuming that your correspondents "take a delight in belittling the enterprise and ingenuity of the British machine toolmaker." At all events, my own feeling is one of actual soreness and irritation at what looks perilously like the loss of our former prestige and supremacy as the world's toolmakers. The best of horses need at times both whip and spur, and if a little adverse criticism will stimulate the older representative firms and enterprising young ones to drive their American rivals from at least the home market, no one will rejoice more sincerely than

December 21st. M. E. C. Co.

SIR,—I have read with much interest the correspondence upon the above subject, arising out of your leading article of December 2nd, and, with your permission, should like to make a few remarks thereon. If, as Mr. Hugh Campbell in his letter of December 5th asserts, that your article is too meek and mild, certainly his statements are far too rash and sweeping, and are not at all compatible with a thorough acquaintance with modern British machine tools and tool builders. It will, perhaps, in passing be interesting to note what has probably been the two chief factors in giving to the Americans that supremacy over British makers in the production of some automatic and labour-saving machine tools which they have undoubtedly enjoyed during the past few years.

First, we must place the restricting influence of trade unionism on the use of such tools in this country. For instance, what would have been said by the union leaders, previous to the strike, to the proposal to bore and face the ends of nine cylinders, 10in. diameter by 12in. long, in ten hours, as Mr. Campbell expects to do on his new American boring machine? Such a thing as this would not have been tolerated, consequently British tool builders did not find it profitable to push such labour-saving tools. In the second place, I think the great length to which specialisation is carried in American practice, enables them in some case to place upon the market a more perfect tool than has hitherto been possible by the average British maker, who as a rule does not confine himself to one or two particular types. This is usually the case with American firms, many of them producing one type of machine tool only. This also in a measure explains how it is that American firms can generally give prompt delivery. To criticise fully each of Mr. Campbell's statements would take up too much of your valuable space, therefore I will confine myself to one or two only.

Mr. Campbell suggests that British tool builders could with advantage study the turret lathes of Jones and Lamson and other American makers. Does Mr. Campbell regard the Jones and Lamson turret lathe as the acme of perfection? If this is so, how is it that in your advertising columns of a few weeks ago a firm offered two of these lathes for sale in first-class condition, giving as their reason for doing so that they were replacing them by other and more modern tools of British manufacture? This looks to me very much as if the Americans will soon have to study British practice in these matters. A word as to planing machines. Is not the limit of cutting speed more a matter of tool steel than planer construction? If tool steel could be produced which would retain its cutting edge, planers might easily have their cutting speed doubled, without finding any insuperable difficulty in the design of their gearing. The assertion as to range of feeds on British planers has been satisfactorily answered by Messrs. Sharp, Stewart, and Co., Limited.

And now to come to the ordinary turning and screw-cutting lathe. Mr. Campbell tells us the feature he does not like in an American lathe is the tool rest; neither, should I imagine, does anyone else, for this is certainly the weakest spot in the whole machine, and utterly inadequate for anything in the nature of heavy cutting. As to the alteration in this particular, our American friends had better hurry up, for they certainly have not made much progress in the last ten years. Again, on some of these American lathes it needs a fair mathematician to find the wheels required for cutting a thread slightly out of the common, and I have repeatedly seen a workman in consultation with the draughtsman on this matter. I have a modern lathe by one of the best American makers upon which such ordinary threads as 11, 19, and 26 could not be cut. What American lathe has such a perfect device for screw-cutting as the quick withdraw motion fitted to most of our British lathes? Again, I beg to inform Mr. Campbell that automatic feed stops are fitted to British lathes, and by more than one firm in this district.

To conclude. Sir, I believe British tool builders do appreciate what is best in American practice, but do not adopt everything they see simply because it is American, for it does not by any means follow that every American importation is the very best tool that can be had for its purpose, as, doubtless, many firms who bought American tools so largely during the late cycle boom have since found to their cost.

I venture to assert that the British tool builder, under the altered conditions which now prevail in this country, will in the very near future more than hold his own, and prove that he is not by any means living in the "fool's paradise" Mr. Hugh Campbell would have us believe.

Acocks-green, Birmingham WALTER WRIGHT.
December 21st

SIR,— The letter in your issue of December 9th on this subject was no doubt written with the idea that the writer was doing a good turn to the toolmakers here by holding them up to such wholesale ridicule. Mechanics in this country will be able to discount the sweeping statements made, but what about foreigners who may read your paper? Will a letter written in this strain serve to increase sales

of British machine tools in other countries? One would think after reading such a letter that this effete old country was rapidly going to the dogs. Has it ever occurred to Mr. Campbell and others that with a population of less than twenty million workers it is impossible for Britain to do the work of the whole world? Even that small proportion cannot all be spared to make machine tools; and if they can make more money by using American machine tools, and making gas engines, for instance, what's the odds?

There are a class of people who are always lamenting about our loss of trade and holding up our puny efforts to the laughter of the crowd, instead of being thankful that we have the necessary wherewithal to purchase the assistance of our neighbours to help us in our rule of the world. If we are so backward in the manufacture and price of machine tools, would it not be better for us to stick to making guns and men-of-war and fighting them for it? We will go again into detail, with your kind permission. Boring and turning mills were made and used in this country quite thirty years ago, according to information I have received; but owing to various causes have not until lately come into favour, either here or in the United States. In milling machines the Americans have a lead in some lines because they have paid more attention to this class of tool, but it is questionable if the workmanship is as thorough as that on our best class tools.

Automatic gear cutters of the pattern no doubt alluded to are not very elderly machines, and are the result of the high price of labour in the States, and the reason they are not made here is that until lately all innovations were tabooed by the workmen. It is surprising that an English planer cannot be got to travel at the rate of 20ft. per minute on the cutting stroke. Why cannot anyone put a larger pulley on the main shaft and drive it as quickly as he wants to? It is quite refreshing to note the way comparisons are drawn on the subject of horizontal boring machines. The arguments are so conclusive that it is quite useless my trying to refute them. It stands to reason that the cutting edge of the tool and the hardness of the material operated on have nothing to do with the speed the boring can be done at. It depends entirely on the design of the machine.

Many people forget that American cast iron is much softer than English, and what will answer on one kind will not do on the other. Gas engine liners are, or should be, made of a very close hard metal, and I should for one like a peep at one that was bored at the rate mentioned. What I cannot understand is why Mr. Campbell bothered an English toolmaker for a price when he knew how much better American machines were. I am afraid Mr. Campbell has not seen all makes of English drilling machines. I could show him some having automatic stops. It will be news to many that we are behind in the number of feeds. Most American drills have only three, and that is about what ours have. It will also be news to know that there are many American firms fitting friction back gear to any lathes but capstan or similar special machines, and a number of English firms do the same. Lathes having automatic stops to the feed have been made here for years, probably before some of the American shops were thought of.

Birmingham, December 23rd. H. RUSTIN.

SIR,—While we are on the subject of tools, would it not be well to have some authoritative statement as to the proper speed at which a cut should be taken? The old rule when I was a boy was 20ft. for turning and 14ft. for boring per minute. I remember asking Richard Roberts what he thought on the subject. "Dicky" replied with a characteristically strong expletive that "the tool didn't know whether it was boring or turning," and that the proper speed was the same for both—20ft. a minute on cast iron.

Hunslet, December 27th. T. W. C. A.

SPANISH WARSHIPS.

SIR,—In your article on "Warships in Action" in THE ENGINEER of September 9th last, referring to the destruction of the Spanish fleet at Santiago de Cuba, you state that they were destroyed in much the same fashion, and at much the same rate, as if they had been unarmed merchantmen loaded with gunpowder, and you are therefore at a loss to account for this, which no doubt appears very alarming. But being intimately acquainted with the design and construction of at least three of the ships referred to, viz., Infanta, Maria Teresa, Viscaya, and Almirante Oquendo, I will, with your permission, point out one or two defects in these vessels, which, in my opinion, were the principal cause, or at least contributed largely to their destruction and I may say that their fate was predicted by the builders, in the event of their ever being in action, long before the ships left the builders' hands.

I hope, therefore, that the information I am about to give you, and which is known to only a few persons besides myself and the Spanish officials who were responsible, will make it clear to all that the ships named were much more vulnerable than the ships of any class in the British Navy, or, indeed, any other navy.

They were in every way strong and well built, and had the designs of the builders been carried out in accordance with the contract and specification, I have every reason to believe their fate would have been different, and in other hands they would have given a very different account of themselves.

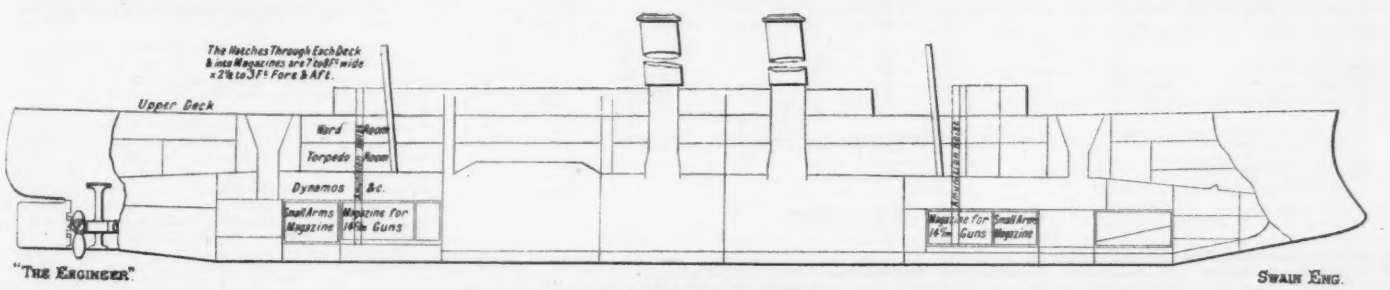
It is pretty generally known that during their fitting out and completion, owing to a dispute between the builders and the Government, the latter took possession of the works, appointing a Special Commission, at the head of which was placed Admiral Cervera. At the same time a royal decree was issued, which stated that the terms of the contract would not be interfered with; but the fact is that no sooner had the younger members of the Commission got themselves comfortably settled down than they began to devise improvements. These gentlemen, I may say, were, without exception, inexperienced in the construction of modern ships of war, and confined their attentions principally to cabin fittings and decorations; the ship, to them, was not a fighting machine, but simply comfortable quarters for their friends, or it might be for themselves. The consequence was that many tons of timber, in the shape of furniture, &c., were placed in the ships that ought never to have been there. For instance, the painting of the beams, and coating the deck plating with granulated cork, horrified them, and all the ceilings of commander's cabin, ward-room, and the sides of the ship throughout the officers' quarters, were panelled. All objections raised by the builders were only laughed at.

But the most serious change of all was the re-arrangement for the handling of ammunition for the 14-centimetre guns. The magazines were altered, and two hoists fitted—one forward and one aft. To do this the decks were cut directly over the centre of the magazines. These hoists led direct to the upper deck, without cover or protection of any kind whatever. It was therefore possible to see into the magazines from all the four decks through which the hoist passed, thereby exposing them to the fire from the enemy's shell, or to burning materials that might fall from any of the decks; and should a shot cut the rope of the hoist, the carriage would fall back into the heart of the magazine. The results can better be imagined than described. It is true a clutch, supposed to be safety, was fitted to grip the guides in the event of the rope being cut; but I think it more than probable that the shot that cut the rope would also carry away one or more of the guides. It is scarcely credible that any body of sane men would approve of such an arrangement; but it is nevertheless a fact that the designs were submitted to and passed by the Technical Commission in Madrid. It is only fair to Admiral Cervera, however, to say that he was in no way responsible, having been called to Madrid to fill a more important position before this work was carried out.

I enclose a small sketch showing the position of the magazines with their hoists, and showing the compartments through which they passed. Although you do not say which of the magazines exploded, I feel pretty confident that they were those I have indicated; at the same time I shall await with interest your further remarks on this subject. The apparent mystery, and the importance attached to the behaviour of these ships, must be my excuse for troubling you at the present time.

With regard to the question of torpedoes, the fitting of above-water discharge tubes in these days of quick-firing guns appears to me almost as great folly as exposing the magazines in the way I have just called your attention to. Several of the other ships destroyed were built in Spain, and it is just possible their magazines were exposed in the same manner.

Nagasaki, November 2nd. M. I. N. A.


The Hatches Through Each Deck & into Magazines are 7 to 8Ft wide x 2½ to 3Ft Fore & Aft.
Upper Deck
Ward Room
Torpedo Room
Dynamos &c.
Small Arms Magazine
Magazine for 14in Guns
Magazine for 14in Guns
Small Arms Magazine
"THE ENGINEER"
SWAIN ENG.

THE INFANTA MARIA TERESA

BRITISH *v.* AMERICAN LOCOMOTIVES.

SIR,—I have had interviews with some of our leading locomotive builders in this country regarding the orders recently reported as having been placed in America by the Midland Railway, and also for the Indian and Australian railways, and I regret to find that the present state of matters in this industry is quite incredible, and that all the orders given out might have been executed in this country had a little foresight been exercised by the responsible officers who advise these railways.

It would only be natural to suppose that with the extreme urgency which has arisen, and which has lately induced locomotive superintendents and consulting engineers to entertain proposals for American engines on account of the early delivery offered, specifications here would have been opened up, tests modified, and even some freedom given to home makers in the matter of design. But this is not so, for while I find that about 200 locomotives are being built at the present time for the Midland Railway by British builders, I understand that these are all to be built in strict accordance with the usual designs and specification of the locomotive superintendent, while at the same time twenty goods engines of the American Mogul type have just been ordered from Baldwin's and the Schenectady Locomotive Works, with, I presume, outside cylinders and minus the usual crank axle of the English engine.

Our home makers are even more seriously handicapped by the consulting engineers in London, and locomotives for India, Australia, &c., have recently been ordered from the United States, of American design, with deliveries promised sufficiently early to prevent the possibility of our London engineers or their representatives carrying out even ordinary inspection at the makers' or sub-contractors' works in America.

We might just as reasonably ask a London and a New York watchmaker each to supply a watch equally expeditiously and at the same price, but while allowing the Yankee to supply a Waterbury, insist that the native production should be a hand-made presentation gold-lever hunting watch, with jewelled mountings, elaborately engraved, and with appropriate inscription. No doubt both watches will go equally fast, but if the Waterbury will do, why demand the other from the Englishman when he might give you an improved Waterbury while you wait?

Even although the spirit of patriotism were entirely absent from the constitution of our civil engineers, our locomotive builders should at least expect that when proposals to supply American engines can be entertained, the restrictions as to design and inspection imposed with an iron hand in normal times might now be materially modified or altogether withdrawn. It is commonly reported that so onerous are the test requirements specified by certain consulting engineers for Indian and colonial railways, and so exacting is the spirit in which these are carried out, that many sub-contractors, before agreeing to quote, insist not only on a careful perusal of the specification, but lay even more stress upon the name of the engineer to whose inspection the material will be subjected, and in some cases have refused to quote, even although the specification was otherwise satisfactory.

If a standard American outside cylinder engine can take its place on the Midland, Indian, Australian, or other colonial railway as an efficient machine, and one which can be depended upon to meet the exigencies of the traffic, and not to block the system by repeated failure, what is the object of our locomotive superintendents at home, and our consulting engineers in London, each fathering a special design of locomotive for the railway with which they are connected, and for which they are expected to obtain the best and cheapest locomotive that can be built in this country? If the standard locomotive from an American builder can now be accepted, still more satisfactory should be the unrestricted home-made guaranteed article from the British builder.

I am not advocating, as some might do, the exclusion of American locomotives from our Colonies, or even from our home railways, although this would result in the reduction of consulting engineers to the rank of inspectors, and locomotive superintendents to that of master mechanics, but I am pleading for the open door, with a fair field and no favour. COMMERCIAL ENGINEER.

December 21st.

HIGH-SPEED AIR PUMPS.

SIR,—In his letter of the 6th December Mr. Bremner says the Smith Brothers and Eastwood air pump I wrote about is "scarcely relevant to the subject of high-speed air pumps," and that in his opinion, "its chief defect lies in the fact that it is horizontal." He also states that "it carries no water seal on the bucket to prevent leakage through the opening."

On the first point it seems to me there are so many features in common between the two air pumps referred to, that if one would be successful at a high speed the other would be also. Certainly the pump I speak of from personal knowledge runs at only ninety revolutions, but that is no admission, nor can it be urged as proof that a pump on similar lines could not be run at the same speed as Mr. Bremner believes the Edwards pump to have been run. My experience of the Smith Brothers and Eastwood pump leads me to think it could be run with equal success and efficiency at the higher speeds named.

I differ from Mr. Bremner in my opinion as to the form of the air pump I illustrated. I consider it a distinct advantage in the Smith Brothers and Eastwood air pump that it is horizontal, and therefore coupled direct, without the complex arrangements for driving inevitable in any form of vertical air pump, and I have yet to learn that I have lost anything by choosing this form rather than the vertical.

As to the water seal, Mr. Bremner seems to speak from theory rather than from practice. At first sight it might appear that the water will lie quiescent in the bottom of the barrel, but in practice it is not so, as may be seen by experiment in any common bath. When the bucket moves, the water at once piles itself up in resistance to the motion, and instead of there being "no seal," the action of the water in the Smith Brothers and Eastwood air pump produces a seal which is most effective just at the moment when it is most needed.

As to "misunderstanding the nature of the conditions which are essential to maximum economy," I would ask Mr. Bremner, supposing there is anything for the pump to do, that is, it is not supposed to be drawing from a closed vessel under a state of vacuum, is there no rise of pressure in the pump when he is bringing down the condenser pressure? If there is not, the pump would be doing nothing, which, of course, in the case of the Edwards air pump, would be granted absurd, and why not in the case of the Smith Bros. and Eastwood pump also? The "two ways of equalising the pressure in the condenser and pump" are continually going on simultaneously in all air pumps, and it seems to me one of the great advantages of the Smith Bros. and Eastwood pump is the facility it gives for equalisation at a low-pressure as near as possible to the minimum pressure of the air pump.

In conclusion, I still say that most people will put up with a little inefficiency if necessary—though I do not admit there is any loss of efficiency in the case of the Smith Bros. and Eastwood air pump—and choose the horizontal where it is admissible, rather than the vertical with its numerous moving parts.

West End Mills, Bradford, CYRIL WEST LUPTON.
December 22nd.

SIR,—I have read from time to time the correspondence in your valuable paper on the above subject, and knowing the interest you take in all improvements in the marine engine, I take the opportunity of informing you and your readers of the result of the last vessel fitted with Mr. Edwards' patent. The steamer Haiching, built by Messrs. D. J. Dunlop and Co., of Port Glasgow, for the Douglas Steamship Company, of Hongkong, was tried on the 21st inst. on the Clyde, and during a continuous run of four hours at 11 knots speed, with 85 revolutions, Edwards' air pumps gave a constant vacuum of over 29in. I regret that, being away from my office, I have not all the particulars of the ship and engines with me; but having taken the leading part in having this pump fitted to this steamer, I am highly satisfied with the result, and have decided that in future wherever possible, I shall adopt the Edwards' system in all specifications. This pump, I may add, is absolutely silent running.

A. J. DUDGEON, Consulting Engineer.
63, Leadenhall-street, December 26th.

RHENISH GELIGNITE.

SIR,—At an inquest held here on December 24th, on two men who were unfortunately killed by a premature explosion of Rhenish gelignite, her Majesty's inspector gave as his opinion that the charge might have been ignited by the friction of the cartridges against the side of the hole. The hole was a vertical one, 15ft. deep, 3¼in. diameter at the top, and 2in. diameter at the bottom. About 15 lb. had been put in, and four cartridges ⅞in. diameter, 3½in. long, tied together, were being pushed home slowly and softly with a wooden rammer, when the fatal explosion took place. It would be interesting, and of the greatest importance to users of this higher explosive, if any of your readers who have had similar experience would give it.

The following is the analysis of the explosive:—"Permitted explosive, Rhenish gelignite, as defined in the list of permitted explosives, consisting of 59 per cent. of nitro-glycerine, 2 per cent. of nitro-cotton, 30 per cent. of nitrate of potassium, 9 per cent. of wood meal. Manufactured March 8th, 1898. To be used with a No. 6 detonator only. When frozen, to be thoroughly thawed before use, in proper warming pans only."

C. H. DARBISHIRE.
Darbishire's Granite Quarries, Penmaenmawr,
December 27th.

THE STRENGTH OF MORTAR.

SIR,—"Simplex" will find some information about the tensile and crushing strengths of lime mortar at pages 331, 338, 394, and 395 of "Stoney on Stresses." N. D. Y.

ALMANACS, DIARIES, &c.

FROM Messrs. John Rogerson and Co., Limited, of Walsingham, Durham, we have received a sort of catalogue, wall almanac, and diary, all in one. The almanac contains some excellent illustrations of the company's works.

Messrs. Joseph Bradbury, Limited, of Congleton and Manchester, are issuing a wall calendar for 1899, having tear-off monthly sheets, which also serve to illustrate the diverse appliances, chiefly saw-milling machinery, made at their works.

From the Accident Insurance Company, Limited, of 10, St. Swithin's-lane, London, E.C., we have received a wall calendar, in which the tear-off date indicator is a prominent and useful feature. The company was founded in 1849, and insures against accidents and disease, in addition to granting indemnities to employers under the Workmen's Compensation Act, &c.

HYDRAULIC SHIELD TUNNELLING IN MELBOURNE.*

By GEORGE HENRY DUNLOP, C.E.

(*Concluded from page* 601).

FIG. 1 shows the type of shield used here in small sewers. It was built of diameters from 4ft. 11in. to 6ft. It had one opening in the bulkhead from 2ft. 6in. to 3ft. 6in. square, fitted with guides for drop planks. Some designs were of the Greathead type, using a combination of cast and wrought iron; others were built entirely of wrought iron or steel of ⅜in. and ⅝in. in thickness.

The Clarke design of shield is shown in Fig. 2. Seven shields, from 10ft. 9in. to 11ft. 6in. in diameter, were built. It was designed to tunnel through bad ground without compressed air, and it worked successfully, especially in silt.

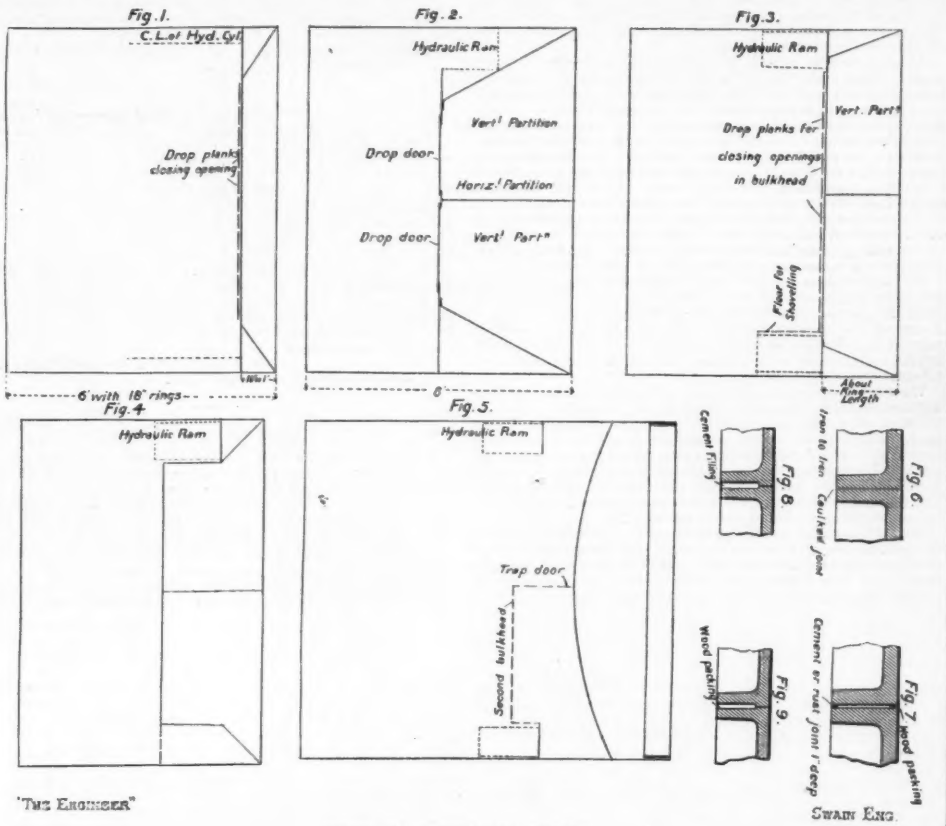
A type of shield suitable for bad ground, but having the bulkhead nearer to the front, is shown in Fig. 3. It is suitable for good ground also.

Fig. 4 shows a shield of medium size having the bulkhead owards the middle of the length. It presents less resistance at the face when being pushed into the ground and provides more room for the workmen or for earth than No. 2.

The Mersey type of shield is shown in Fig. 5.

In the small shields of about 6ft. diameter there is neither space nor necessity for compartments, and they are not used. And in order to allow as much room as possible for the men within the shield, and to keep the length as short as possible, the bulkhead is necessarily put within about 1ft. of the cutting edge—Fig. 1.

The position as to the type of shield may be summed up in this way:—The short front type of shield is most suitable in good ground. Bad ground should be made good by the use of compressed air. But if the material is very soft or sandy, or if sufficient air pressure cannot be obtained, front partitions will assist in holding up the face. But the front should be arranged to give as much working room as possible for the men. The horizontal partition in variable ground is specially valuable. Finally in bad ground, where air pressure cannot be used, partitions should be used in the larger shields. In this case the principal matter for consideration is the position of the bulkhead.



TYPES OF HYDRAULIC SHIELDS

The writer favours putting it about a ring length from the cutting edge in shields of medium size, such as 10ft. diameter, and leaving the whole front clear of rams for the spoil forced in when shoving into the ground—Fig. 3. In very large shields the Hudson River type would be adopted—Fig 4. The matter largely depends on the size of the shield, and consequent possible size of the compartments. If the compartments must be made so small as to prevent a man from working with reasonable ease the bulkhead will be placed forward so that the man can excavate standing behind it. If the compartments are large enough for a man to work freely in them, the bulkhead may be placed well back, say 4ft. from the cutting edge so as to leave full room for the man to work in the compartment, and for this purpose at least 5ft. of height is necessary, and 6ft. would be better. The larger size of shields, such as that at the Hudson River tunnel permit this. There has not been apparently any case in Melbourne where the front large compartments would have been necessary or advantageous if full air pressure had been used.

A projecting circumferential hood and partitions were bolted in front of a shield under the Stoney Creek. The effect of thus prolonging the upper cutting edge by the hood was to allow the face to be battered so that it would stand better, and to cut off any inrush from the top by keeping this hood cutting edge always thrust into the solid ground.

The Mersey tunnel shield, Fig. 5, has a curved bulkhead 2ft. to 3ft. from the cutting edge, with small openings for access to the face. These small openings caused the work of excavation to be slow. Afterwards an enlarged opening was made in the curved bulkhead, and a second bulkhead rising to mid-height was fitted behind it, as shown by the dotted lines, with a movable trap-door closing the top opening across to the front diaphragm. This second bulkhead was put in to check sudden rushes of sand and water. Here the horizontal partition in front, together with a ready means of closing the top openings, effected the same purpose. The Mersey shield was 10ft. 3in. in diameter. If this was considered too small to have four front compartments, the horizontal partition could be placed 6in. to 9in. below the middle and the upper vertical partition alone used with it.

In the construction of the outer shell there are two practices. Either it consists of two plates of equal thickness breaking joint, or of one plate with cover plate joint. The second is undoubtedly the better construction. The first would require the most accurate abutting of the plates at the joint. The writer has examined a shield built in two plates, and found in several places one plate broken and the other not. This showed, as might be expected, that they did not act in unison.

Projecting teeth for breaking down the ground in front of the cutting edge have been proposed but not used here. They have been used in England successfully.

Fittings and power.—No considerable improvement has been made, or appears necessary, in the arrangement of rams and fittings of the Greathead shield, described and illustrated in connection with various tunnels.

Excavation.—Three processes are adopted in regard to the excavation—advance timbering, or the assisted shield method; clearing away a space in front of the shield without timbering—at least, without any complete system of timbering; and the independent shield system, in which the shield is forced into the earth which is excavated within the shield.

The only case in which advance timbering has been adopted here as a regular system was at the Yarra Tunnel, at Spottiswoode, during the earlier half of the work. There the shield, hand-pumps, and system of working was substantially that used in the Glasgow tunnels,* except that no heading was carried in advance, each 2ft. 9in. ring length being taken out ahead of the cutting edge successfully. With full air pressure equal approximately to the hydrostatic pressure, this plan was practicable but slow and costly. It was afterwards amply demonstrated that with 18in. ring lengths, and proper air pressure, this complete system of timbering was not required. In the system in practice at the Glasgow Tunnel it is difficult to see the use of a shield, and particularly the strong cutting edge. Here the advance timbering system has not been found necessary.

At the Yarra Tunnel, in the second contract, the next system of excavation was practised. In front of the bulkhead there were bolted in one vertical and one horizontal partitions projecting about 2ft. All the ground above the horizontal partition, converted by the full air pressure to good standing, firm, sandy clay was excavated away, especially in the interior, sufficiently to allow the shield to be pushed an 18in. ring length. Timbering was not necessary, but light temporary timbering sufficient to steady the face could have been used, consisting of boards across the face with light temporary props against the bulkhead; these props could be removed, or would be broken as the shield was pushed forward. This was done when necessary at Graham-street, Port Melbourne. Below the horizontal partition the ground was coarse and fine sand, above the level, where the air and water pressure balanced, this stood well; below that level light timbering was adopted to hold back the wet running sand around and in front for the bottom 2ft. or 3ft., to enable the sand and the rock boulders to be removed. The shorter ring lengths greatly facilitated progress, though the longer rings would probably have been quite safe, especially if the 2ft. 9in. advance were made in two stages. Afterwards in firm clay, when all partitions had been removed, the ground was excavated far enough ahead of the cutting edge, but to a smaller diameter, to allow the shield to be pushed forward for a 2ft. 9in. ring. In this way from one-third to one-half of the clay would be broken down for the shovellers.

The plan of forcing the shield forward and allowing the soft material, especially silt, to squeeze through the door, was adopted in several contracts. It may be said generally that it is a suitable method only in silt.

Direction.—To ensure accuracy of line and level is difficult, especially in bad ground. It should be most easy in the advance timbering method of excavation, and possibly this is partly the cause and justification for that system. Two special matters only need be dealt with. The shield has a tendency to roll. This is due to some peculiarity of the construction, and sometimes it may be due to the ground. Rolling may be prevented and sometimes rectified by incompletely excavating the upper portion of the face on the side to which the shield is tending to roll, and the lower portion on the opposite side.

The lining.—The lining used with the shield should be strong, impervious to water, easy of erection, and require as little underground work as possible while working the shield. The construction should be such that the joints will not wash out with water, and the ring will not readily yield to unequal pressures. The various systems used in Victoria will now be described.

Concrete blocks.—The first lining used in Melbourne shield work consisted of concrete blocks set in cement. The following dimensions were adopted for an 8ft. sewer at Port Melbourne. The rings were 18½in. long, containing seventeen blocks 18in. long and twenty-two blocks of half that length, equivalent when set to eleven of the former. The lining was 15in. thick, having 1½in. of outer rendering and 12⅝in. of concrete in the block and a final ⅞in. rendering when in position. The blocks were made in tapering moulds with the sewer face of each block underneath, and the 1½in. rendering was applied while the concrete was quite fresh.

The concrete-block system of lining was fully tried, and it must be admitted that it only partially realised the anticipation generally held when it was first introduced. Its advantages were such as to make it eminently suitable to our circumstances and worthy of trial. It was cheap, and if it could be effectively constructed it would be most reliable and durable. But it had two radical inherent constructional defects. As the shield was pushed forward, the joints, partially set, were broken by the pressure used in shoving the shield, and by the alteration of form of the ring of blocks in passing out of the shield into the larger area of excavated ground. No means to sufficiently overcome these defects have yet been brought forward. If they could be overcome the merits of the system would be great, and its extended success assured.

The remaining difficulties were remediable. The water washed out the fresh joints, the block sometimes crushed under the heavy pressures of the hydraulic jacks, and as the work was practically completed as the shield advanced, any departures from the proper level or direction could not be corrected without reducing the size of the sewer. In most cases the use of sufficient air pressure would prevent the joints washing out until set. The crushing of the blocks could be prevented by a better distribution of the pressures, by increasing the end areas of the blocks, and by increasing the strength of the concrete, if necessary. The head of the ram pressed against the middle of a "pressing beam," resting against the ends of the blocks. The short toothings were brought up by 4½in. "toothing blocks." This arrangement could be improved. Even with 12in. by 6in. pressing beams there would necessarily be unequal pressures on the blocks. And it was difficult to get the toothing blocks to accurately fit and give an equal bearing for the pressing beam. Should they be too small, the long toothing blocks might be crushed, while the short toothing blocks might be unloaded. By diminishing the number of the blocks in the ring, or increasing the number of hydraulic rams, there could be arranged a ram for every three blocks, and upon these the pressure could be more equally distributed. The shield could be pushed forward without exceeding a thrust of thirty-six tons by any one ram, and this thrust could be distributed so that not more than eighteen tons could be imposed on any one block. This pressure in working conditions of blocks of suitable size would not be excessive for the few repetitions to which they would be subjected. Bluestone blocks were used in conjunction with the concrete in order to prevent crushing. The difficulties of securing correct alignment and level were mainly due to the bad ground, and could be proportionally removed by the use of compressed air.

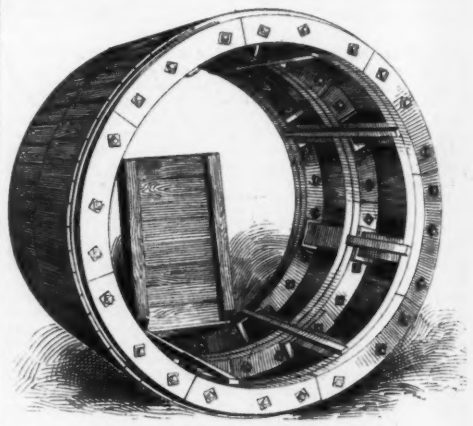


Fig. 10—SHIELD WITH WOOD LINING

Bluestone blocks.—Bluestone blocks were suggested instead of concrete for the sewer under Stoney Creek in order to get greater strength to resist the thrust of the jacks. Their use presented no other gain, and could not obviate the inherent defects of the system. Under the particular circumstances regulating the respective prices of stone and concrete blocks in late years, the bluestone would cost about one-half more than the concrete blocks delivered at the shaft, and as the strength would be very much greater the bluestone is relatively cheaper. But under past normal conditions in the stone trade the bluestone rocks would have cost from two to three times as much as concrete blocks, and as a minimum stable thickness would be necessary, the strength of the bluestone would be too dearly purchased.

One special case of successful work may be given. For part of the length of a 4ft. 3in. sewer to be constructed of brickwork there was about 30ft. of wet sand with 3ft. to 4ft. of excellent clay above the crown of the tunnel. In timbering this ground about 18in. at least of the clay above the tunnel would necessarily be broken down, and the remainder could not be held up as tightly as it would be over a shield. The water would come through, disintegrate the clay, and "runs" of sand would follow. It was decided to abandon the ordinary timber method in favour of shield tunnelling. Bluestone block lining was selected. There were eighteen stones 18in. long, and 9in. thick, in each ring, set in two to one cement mortar with 4½in. toothing. All the blocks were of the full length, but the nine lower blocks were larger, occupying nine-sixteenths of the full circle. After the sewer had progressed some distance the following method of carrying out the work was adopted:—Instead of building the ring within the tail of the shield, only three or five of the invert stones of a ring were built there, and the remainder of the ring, really the completion of the preceding ring, was built immediately behind the shield, the clay standing up unsupported for the length of time necessary to allow of this being done. In building in this way the space due to the thickness of the shield and any other vacuities were filled with sand packing. Thus, one of the already-mentioned inherent defects of the block system could be overcome. No spreading deformation of the sewer took place, and excellent work was effected. Of course, the circumstances were unusual, but the method selected was certainly a good one to meet them. In one or two places wet ground was met with, and the building of the ring was done within the shield. The defects of the system at once asserted themselves.

Cast iron lining.—In the ordinary systems of cast iron the lining length of ring has varied from 12in. to 33in. The most suitable length will be from 18in. to 24in. Long plates are not economical. With the same design of flanges any lengthening of the ring simply reduces the proportion of metal in the circumferential flanges, where metal can be most suitably disposed to give strength to the lining. Different designs of joints are shown in Figs. 6, 7, 8, and 9. In Fig. 6 a longitudinal machined joint fitted metal to metal is shown with a space for caulking with cement, or for a rust joint. This is the best form. Fig. 7 shows a good type of joint for general use and for both flanges. A ⅛in. soft wood packing is placed between the flanges. This packing will tend to swell, and so correct any slight inequalities in the fitting of the cast iron. It

* Read before the Victorian Institute, August 3rd, 1898.—Slightly condensed.

* Trans. Inst. C.E. CXXV., 383.

will be better, but not entirely necessary, to have the flanges, especially the longitudinal ones, machined. There should be a space of about 1in. deep left for caulking, so that the lining may be made water-tight. This joint is stated to have been made entirely water-tight in wet ground in London, using iron cement for caulking. Figs. 8 and 9 show types used more particularly for circumferential joints. The joint shown in Fig. 9 has, however, been largely used between the longitudinal flanges, with soft wood packing into which hardwood wedges are afterwards driven in order to make it tight.

The rigidity and the truly circular shape of the ring are of great importance, and the breaking of the joints should be a superior plan in both respects, for in this way each plate becomes a cover plate over the joints of the adjoining rings. If the rings are tightly and strongly bolted together the lining must evidently be more rigid than when it depends for stiffness entirely upon the longitudinal joints. The shield and the iron lining are made circular and with from 1in. to 2in. of difference in diameter. In building the ring with the lower half of the iron lining in contact with the shield, the ring has an initial departure from the circular shape, and defective bearing at the longitudinal joints. If, now, it were attempted to attach another ring, with considerable breaking of the joints, the rings would not fit accurately, and unless the bolt holes were considerably larger than the bolts they might not fit at all. Therefore it becomes necessary to build the ring more accurately to the circular shape. The importance of the bolting of the circumferential flanges is greater when the joints are not continuous, and as the bolts do not fit the holes closely, their efficiency depends upon the tightness of the screwing up. There should be no special difficulty in arranging the rings to break joint.

Where, as in Melbourne, the longitudinal joints are continuous along the tunnel, the purpose of the bolts in the circumferential joints is mainly to draw and hold the plates together in order to ensure a close joint in all cases. If the rings be closed together by the hydraulic ram pressure, as can readily be done, the bolts only require sufficient strength to retain the plates in close contact. It is impossible to estimate what forces there may be tending to separate the rings, but it does not seem likely that they would increase more rapidly than the diameter of the tunnel. If, then, a constant pitch be adopted, it follows that the diameter of the bolt need not increase with the diameter of the lining. There does not seem any necessity for more than ⅞in. to 1in. bolts for any size of tunnel. And a man using an ordinary spanner will not overstrain a ⅞in. bolt. Unless, then, a greater length of spanner is insisted upon, there is no advantage in any case in increasing the size of the bolt, for its strength will not be utilised. The pitch should be from 6in. to 12in., and probably 9in. would be about right. For the longitudinal joints the case is different, for the rigidity of the joint depends upon the depth and fitting of the flange joint, and the tightness of the bolting. This relates to the total strength of the bolting. The strength of each bolt may be whatever the spanner used will utilise. The size may be ⅞in. for 6ft. diameter, and ¼in. more per 4ft. of increase with 6in. to 8in. pitch, according to the class of the ground and strength of flange.

In a 5ft. 9in. sewer lining in Melbourne the cast iron rings were 15in. long with 1in. metal and flanges projecting 3½in. They were bolted together with ⅞in. bolts at 6in. pitch. This lining collapsed in two cases under exceptional circumstances, mainly through the ground getting away underneath, and thus causing an undue strain in the lining. In this case the iron and bolts both failed, but the cast iron much more extensively than the bolts. It was clear that fewer bolts would have sufficed to utilise the strength of the cast iron plates. There were no brackets.

In designing and constructing sewers, especially in pumping schemes, it will be of importance to consider the extra cost to which it is advisable to go in order to exclude leakage. The expenses due to leakage will be extra cost of pumping, reduction of effective area of sewer, and general charges. Suppose one mile of sewer 8ft. in diameter costs £60,000, and admits 3000 cubic feet of water per hour. Estimating the cost of 1,000,000 cubic feet per day 1ft. high at £30 a year, and taking the lift as 120ft., the annual cost of pumping this leakage will be £260, and at 4 per cent. interest this will represent a capital sum of £6500, or about 10 per cent. on the cost of the sewer. Again, assuming a velocity of 3ft. per second, the discharge of the sewer will be about 540,000 cubic feet per hour, of which 300 cubic feet will be leakage, being in this case $\frac{1}{1800}$th of the hole. And this will apply to every succeeding mile of the sewer to the point of discharge. If this length be 12 miles there is a sum equivalent to 7 per cent. of the cost of the sewer rendered non-effective. There would be further charges for distribution and treatment.

In the case stated, then, it would probably be better to spend £75,000 on a water-tight sewer, if it were possible to get it, than to spend £60,000 on the one which leaks. Of course, this calculation is rough, and is made simply to show the importance of the matter. Now cast iron and wood are the only linings used here which could certainly be made water-tight. The cost of a cast iron sewer in a shield tunnel is one-half more than that of a brick sewer in an ordinary timbered tunnel, and the wood-lined sewer about the same as the brick sewer. The extra cost to exclude leakage would not be considerable for iron or wood-lined tunnels. In the Melbourne sewers a thick concrete lining was put in. With cast iron lining the concrete or other internal lining should not be put in under compressed air, at least until the iron lining has been made as water-tight as possible, and tested by reducing the air pressure. Otherwise leaks in the lining, which might be caulked, will be covered up.

Erectors are used for putting the plates in place in large tunnels. Two erectors were built in Melbourne. Each consisted of a truck, upon which was fixed the erector, consisting of an arm raised and extended by toothed gearing. The trucks were mounted on rails of wide gauge, under which there was room for the earth trucks to pass. The erector was cumbrous, and on the one occasion that the writer saw it working, it appeared to be slow and clumsy. The second erector was not used to any extent. These designs were not suitable, and they appeared to have discouraged the use of erecting machinery. The plates were erected generally by the men without such assistance.

Wood lining.—A patented system with wood lining has been designed, and used with the shield at work at North Yarra Main section, No. 6a, at North Melbourne. As this system is comparatively unknown, a model and a design for a small sewer are shown (Fig. 10). This design was prepared by the writer for the construction of two full-size rings shown in the photograph. The suitability and safety of the system have now been determined by its successful use over a length of more than half a mile of tunnel of 10ft. in diameter.

The cost of 6ft. 9in. sewer given later indicate the objection to cast iron clearly. It is too costly. But in Melbourne work in bad ground it has these great advantages over such systems of lining as concrete and bluestone blocks—that the joints are not such as will be affected by water, the lining can be caulked more readily, and, above all, whatever deformations may take place in the outer lining, the final internal concrete lining can be placed in position in a continuous mass, and without being exposed to subsequent disturbance. Half the cost of the completed work is about the actual price paid in Melbourne for the iron lining delivered at the shaft. The similar actual cost of the wood lining would be about one-fifth of the total completed cost of work. The cost of a finished concrete sewer with wood lining would be about 70 per cent. of the cost with cast-iron lining. As shown in the drawing and model, the wood lining is built in rings composed of sections. Each section consists of two rib segments spaced the ring length apart, and covered on the outer side with boarding. Between the rib segments are placed thrust blocks, which will form continuous lines of struts to resist the pressure of the rams of the shield. Each succeeding ring is built so that the joints of its sections "break" with those of the preceding ring. Thus the lining has, at ring-length intervals, ribs really composed of two layers of wood secured together by bolts and breaking joints so that the whole will act as one piece. Of course, this result can only be secured by spiking the ribs together, or by drawing them together with strong bolts well screwed up. Probably the former would be the more efficient, and the latter the more convenient method.

It is of importance that each leading ring of rib pieces be accurately retained in shape until the next ring has been securely attached to it. When the shield is shoved forward the earth on top of the lining will usually close down and press upon it before, or heavier than it will at the sides. To prevent deformation in the larger excavated area behind the shield it has been proposed to use a strong square "sett" of timber temporarily. This sett will be removed when the ground had closed around the lining.

Grouting.—It would seem, both to prevent the deformation of the ring and to form a continuous coating, that the grout should be injected simultaneously with the advance of the shield, or, at least, for every one or two rings. The writer has never obtained any precise information as to the practice in this respect in other countries. Matters such as this, apparently, perhaps, trivial, but really important, are not dealt with. Grouting will not be so useful in silt not carrying water, for the silt will close in quickly and evenly around the lining. In running ground, such as sand, unless air pressure is used, the grouting is not likely to form a continuous coating to the iron as the sand in the roof falls too quickly. Besides, the grout will blow into the ground opposite the grout-hole, and though the vacuities may ultimately be filled up, in many parts it will be with the sand, or with a mixture of sand and grout. Grout will form a most effective coating in ground so firm that it will temporarily retain its place unsupported till the grout can be injected, but where the injection of the grout is not simultaneous with the advance of the shield, or substantially so, the coating of grout is so imperfect that it is of use merely as a filling to prevent settlement of the ground and deformation of the lining.

Compressed air.—Whenever it becomes necessary to use special timbering and precautions, compressed air should be used with the shield in wet ground, to assist to hold up the face and to deal with the inflowing water, unless the amount of work of this class is so limited as to render the cost of air plant too great. The advantages of compressed air are, that water can be excluded, or so much as cannot be excluded can be readily dealt with, and that running ground in which effective work is impossible can be converted into good ground. The pressure to be adopted should be sufficient to render the ground easily worked and no more, unless it is necessary for safety in subaqueous work, or purely for the exclusion of water in order to facilitate building the lining. With pure air up to a pressure of one atmosphere no effect is apparent upon men of good constitution and in good health—and persons not in good health should not subject themselves to compressed air. Under these circumstances men can work hard and regularly for eight hours per day without inconvenience. At the Yarra Tunnel at 20 lb. pressure the men worked six hours per day. Pressures of 2½, 3 and 3½ atmospheres have been used with short hours. In the highest pressures the working time appears to have been four hours. The greatest air pressure to which the human body has been subjected was about 77 lb. per square inch, for a period of two hours in some experiments in France. About 35 lb. per square inch may be classed as the greatest ordinary feasible working pressure for large operations.

The air should be as pure as possible. The electric light only should be used—candles are very objectionable. At the Yarra Tunnel at first the escape of air was so great at the shield that the atmosphere was naturally pure. Later on the shield passed into clay with little escape of air at the face, and the air became very impure, especially as in addition to the electric light candles were largely used. The men now suffered from muscular pains. Personal experience on this and other works show that with the pressure used in Victoria up to 21 lb. per square inch, the impurity of the air is much more impressive than greater pure air pressure would be, and more detrimental to health. No trouble was experienced at Graham-street, Port Melbourne, after compressed air was used, from foul gas which had shown itself in the shield before. If it be possible to maintain an air pressure greater than the hydrostatic pressure with a free current of fresh air supplying an exhaust from the face, foul gas cannot collect in dangerous quantities in a tunnel. With less than the hydrostatic pressure if gas is present in the soil it may be expected to enter. At the Yarra Tunnel repeated careful levels showed that the water showed itself in the sand at about the level where the air and hydrostatic pressures became equal. As the water could come freely through the ground around, this would be expected. It appears not to have been so elsewhere.

Three types of air lock was used here. In the Yarra Tunnel an air lock consisting of two brick bulkheads with heavy cast iron doors were used. In the second contract another lock was added and the first was left as a safety lock. This was a wrought iron riveted cylinder, 10ft. long 5ft. 6in. in diameter, with ⅜in. plates and ends ½in. thick with stiffening gussets, and with door openings just large enough to pass the ordinary mining truck used on the works. The third type of air lock was used in small cast iron lined tunnels. It consisted simply of two wrought iron bulkheads bolted to the circumferential flanges of the iron segments, with wrought iron doors as before. This portion of the tunnel lining was thoroughly grouted. The connection between the bulkhead and cast iron lining was made air tight with neat cement plaster over the joints. The cast iron longitudinal flanges were cut away where the bulkheads were attached, and the bulkheads were stayed to the tunnel lining. This and the wrought iron locks are most suitable in their respective circumstances. The brick type is expensive and slow of erection, and still more expensive and slow in removal. It has been said that the workmen preferred brick air locks to iron ones in London, as the chilling effect of the fall in temperature when coming out of the lock was less. In air locks in England it is the practice to build the iron air locks in, and entirely to support them against the internal air pressure by a brick bulkhead wall. A better plan practised here is to strut the air lock by strong timbers to the tunnel lining behind, and so reduce the necessary thickness of the brick wall. A 9in. brick wall with a manhole opening in the centre has thus been used successfully in a 4ft. 3in. sewer against 15 lb. of air pressure. The wrought iron locks could be more readily moved forward if required on the work, and might be used elsewhere.

Sub-aqueous tunnelling.—Sub-aqueous tunnelling differs in two respects only from ordinary bad ground tunnelling. Special adjustment of the air pressure must be made, independent of the hydrostatic pressure to be restrained, in order to avoid blowing out the overlying ground; and special safety provisions must be made for the men in case of a sudden inrush of water. The air pressure is approximately the same at the crown and at the invert of the shield, while the hydrostatic pressure is not so. If, now, the weight of earth be taken as double that of water, it follows that the air pressure necessary at the invert of the shield to balance the hydrostatic pressure there, will be safe provided the depth of ground above the shield is not less than its diameter. In the Yarra Tunnel, at Spottiswoode, the shield was 11ft. 2½in. in outside diameter, and the minimum depth of ground overhead was 12ft. There was no reason then to fear blowing out with any pressure necessary to restrain the inflow of water. It has been stated that the air pressure was at one time kept low in order to avoid this supposed danger. Of course it is advisable to keep the air pressure lower than the weight of earth and water above, especially if the ground were very loose.

It is advisable that the grouting should be kept close up to the shield to prevent fretting away of the ground into the vacuity left behind. Ample air compressing power and plant are necessary. At the Yarra Tunnel there were three air compressors with air cylinders 16in. by 14in., 20in. by 12in., and 14in. by 12in., with two portable engines and one vertical crane boiler, equal in all to 42-horse power. This machinery was at one time fully taxed to maintain 20 lb. of air pressure. The ground was good firm sandy clay, but full of holes up to ½in. diameter, through which air escaped.

Comparison with other methods of tunnelling.—The shield system may now be compared with former methods of tunnelling with regard to safety, expedition and cost. The shield system properly carried out is safe, especially in all cases where full or nearly full air pressure can be used, and in this respect much superior to ordinary timbering in difficult ground. As to the rate of progress, the following examples afford a fair comparison. In a contract for a small sewer the ordinary tunnelling was carried forward 10ft. per day without the concrete and brick lining. The rate of progress with a shield would have been about the same with block lining, and about 30 per cent. more with cast iron. At Graham-street the best rate of progress with concrete blocks and compressed air in sandy silt was about 100ft. in fourteen days, or 7ft. per day. With ordinary tunnelling in sandy clay seventeen days were spent in driving the advance heading and six days in excavating to full size and lining, or a total of twenty-three days for 100ft. Rates of progress up to 20ft. per day have been made here with iron and wood lining in good material such as silt and clay. With cast iron and concrete lining, the shield system will not be adopted in Melbourne so long as satisfactory construction can be attained with ordinary methods, because of the high cost of cast iron. Wooden lining can be successfully constructed, and the shield system will be advisable so soon as the ground becomes soft enough to require what may be called complete close timbering, especially in wet ground. The relative costs of sewers hereafter given show this, the costs of ordinary brick sewers being given.

An important matter concerning the relative advantages of the shield and the ordinary timbered methods of construction may be noted here. In the shield system the area of excavation does not largely exceed the area of the construction placed within it. The small space left is either specially filled with grout or gradually filled by a comparatively slight closing in of the unsupported earth. Afterwards water outside of the sewer cannot flow freely around it, seeking access to the interior at every weak point. And this is just what does happen in the ordinary timbered system. Spaces about the timber, necessarily left in position around the sewer, form channels for the water, and the whole outer surface is exposed to its pressure. In giving the following costs for a 6ft. 9in. diameter circular sewer, it is not considered necessary or proper to illustrate by drawings the various constructions, nor to give the detailed schedules and the quantities and rates from which they are compiled. The brick sewer constructed in the ordinary timbered tunnel, the cast iron shell and concrete sewer, and the wooden shell and concrete sewer, are all ordinary types suitable for soft ground. The cast iron lined sewer with concrete filling between the flanges only, is given, although such a construction here is not recommended for a sewer. All the prices are estimated.

	Per 1ft. £. s. d.
1. Brick sewer. Ordinary tunnelling	6 15 0
2. Cast iron shell and concrete, soft ground	10 0 0
3. Wooden shell and concrete „	6 15 0
4. Cast iron shell with concrete lining between the flanges only	3 5 0

Of these types it may be said that fairly good ground is presupposed in the first case, and if the ground is wet the sewer will leak. Types 2, 3, and 4 can be made practically water-tight in any ground, and for Melbourne sewers, where iron has been used, type 2 is worth more than the excess cost over type 4.

Future developments.—The developments that may be expected with the shield system in future are mechanical excavation, improved systems of lining, and the use of the shield for what may be called sub-surface tunnelling, as in streets. At present half or more than half time is required in breaking down the ground and shovelling, and any system of more rapidly effecting this work would increase the rate of progress, and thereby reduce the part of cost due to the heavy charges outside of those for labour within the shield. Mechanical excavation has long been suggested, but it will probably be found difficult to effect, except in firm ground.

The following figures are compiled mainly from actual contract prices, and they afford fairly accurate comparative information as to the relative costs of different types of 4ft. 3in. circular sewer. The differences in the ground are indicated.

Concrete lining in good ground with no water (estimated)	100
Bluestone lining in good ground with no water	107
Wooden lining in wet ground with compressed air and without grouting (estimated)	114
Brick sewer in good ground for ordinary timbered tunnel. Without shield	126
Cast iron lining in wet ground with compressed air and without grouting	190

These figures indicate how largely the shield should displace the former systems of tunnelling in wet ground, since the cheaper wooden linings can be effectually constructed.

AMERICAN ENGINEERING NEWS.

(From our own Correspondent.)

A new pyrometer.—The chemical composition of iron from the blast furnace has a very considerable effect upon the temperature in the ladle, which temperature is a very important matter in regard to casting. In making heavy castings, there is great danger in pouring too hot or too cold, but at present there are only empirical methods of determining the temperature of the molten iron. Mr. Moldenke, in investigating this matter, took up the idea of modifying the Le Chatelier pyrometer in such a way as to make it available. In this device two pieces of wire of slightly varying composition are used, and the heating of the junction of these produces an electric current proportional to the heat, which current is measured by a galvanometer. While this device is extensively used for recording very high temperatures in kilns, it would be at once destroyed if immersed in molten iron, and the long porcelain protecting tube would be quite useless. In the modified pyrometer two parallel wires are used, one of platinum and the other of rhodium alloy, and these are fused together in a loop at their outer ends. Each wire is wrapped with an insulated covering of asbestos. These wires are contained in an iron tube, to the end of which is attached a fire-clay tip, which encloses the ends of the wires and the fused point. The tip may be in a line with the tube, or at right angles to it, or may have a flexible connection to the tube, so that it can be set at any convenient angle. A hollow conical shield on the tube, lined with asbestos, protects the operator's hand. On the end of the tube is the terminal box, containing the binding posts for the pyrometer wires and for the copper wires leading to the galvanometer. The latter pass out through the handle of the instrument. Sufficient experiments have been made to show the practical accuracy and value of this pyrometer.

Cheap gas and gas engines.—One of the gas companies at Boston has applied for permission to supply coal gas of 18-candle power instead of water gas of 25-candle power. The new gas is to contain less than 10 per cent. of carbonic oxide, and its cost is to be 3s. 1½d. per 1000 cubic feet if used for fuel. If used for power purposes in gas engines, the cost is to be 0·6, 0·55, and 0·5 of a penny per horse-power hour for engines of less than 100-horse power, less than 200-horse power, and over 200-horse power respectively. In small steam engines the coal consumption is nearly 10 lb. of coal per horse-power hour of actual working time, equivalent to 1d., or just twice the cost for gas in a gas engine. The net cost of electric power is estimated at 3¾d. to 1¾d. per horse-power hour, depending upon the quantity used. It is thought that this is the beginning of a movement which will spread to other cities where cheap fuel gas can be manufactured and used for heating and power purposes. In such cases it will be an active and serious competitor in the field of electrical companies, which

now supply current for both light and power. For a certain class of buildings, if fuel gas is cheap, it will be cheaper to generate electricity for light and power by means of an independent plant, consisting of gas engines and dynamos, than to buy the current from the electrical companies, or to generate it by means of a steam plant. While the gas plant would not be available for heating purposes like the steam plant, yet a combination of gas engine, electric dynamo, and low-pressure gravity steam-heating system, would in many cases be the most economical. For city manufacturing plants, machine shops, printing houses, &c., a gas engine plant operating at two-thirds of a penny per horse-power hour would furnish power at a cheaper rate than it could be obtained for from an electric supply company or from a steam plant.

Electric lift engines.—The electric hoisting engines which are to be put in by the American Sprague Electric Company for operating the forty-eight cars of the lifts on the Central London Underground Railway will be of the company's tandem worm gear type, which is entirely self-contained, requiring only the attachment of the cables and the controller wires. Upon a heavy base plate are mounted two side frames of box pattern, in which are formed the bearings for the drum and idler shafts, and the oil tanks in which the worm and worm wheels and the locking gears are immersed. The motors are bolted to the bed plate, and mounted on the ends of the two worm shafts, which are at right angles to the drum and idler shafts. These motors are shunt wound, ironclad, of the four-pole enclosed type used in tramway service. They take current in series with each other from the feeders and the third rail. By putting the motors in series, the duty on each side of the machine is equalised for all speeds. When a descending car is loaded, the motors generate and return current to the line, which feature is expected to materially reduce the total current consumed by the entire plant. On each worm shaft are two worms, gearing with the two worm wheels, one on the drum shaft, and the other on the idler shaft. In this way all side thrust on the drum shaft is avoided, while the two worms balance all the end thrust. When the motors are running at 470 revolutions per minute they will give a speed of 200ft. per minute to the car in the shaft. The worms are of the Hindley type, which have a much greater bearing area than those of ordinary construction. The maximum net pull on the hoisting ropes is 12,000 lb., but the pull will ordinarily not exceed 9500 lb., the rest of the load being balanced by counterweights.

Boilers for the navy.—The annual report of Commodore Melville, Chief of the Bureau of Steam Engineering, United States Navy, contains some interesting information in regard to boilers for naval vessels. Among other things, it is stated that seamless drawn steel boiler tubes have been made of a degree of excellence undreamed of a few years ago. The cylindrical boilers for the new battleships of the Alabama class were to be of plates $1\frac{7}{16}$in. thick, the metal having a tensile strength of over 65,000 lb., an elastic limit of over 35,000 lb., and an elongation of 24 per cent. in 8in. There has now been adopted, however, a steel with a higher carbon content, oil tempered and annealed, which has a tensile strength of over 74,000 lb., an elastic limit of over 40,000 lb., an elongation of over 21 per cent., and a very satisfactory cold-bending test. Even with the higher pressure now adopted beyond that originally intended, this steel will require a slightly less thickness in the plates. With this high-grade boiler steel the braces and rivets will be of nickel steel. The other new battleships were intended to have water-tube boilers designed by the Bureau, but as these vessels were to be practically identical with the Alabama class, the use of these boilers would have involved a readjustment of the hull weights to maintain the trim. The contracts were therefore awarded on the basis of cylindrical boilers, but as the builders will prepare their own machinery designs, in order to obtain the 18-knot instead of 16-knot speed, it is probable that the water-tube type of boiler will be used. The demand for high power and pressure on a small weight practically rules out the cylindrical boiler, and Commodore Melville is in favour of the water-tube type. In the blockading vessels all the boilers had to be kept under steam, with heavily-banked fires and a large coal consumption, but water-tube boilers, enabling steam to be raised rapidly, would have put the ships under better control. Such boilers can also be repaired or rebuilt in place without disturbing the decks. In fact, the old monitors which were furbished up for coast defence service during the recent war had the old boilers cut apart and taken out, and Babcock and Wilcox water-tube boilers put in without disturbing the decks, the boiler sections being passed down through the funnel openings.

Steel head frames for mine shafts.—In the coal-mining region of Pennsylvania many of the shafts are fitted with steel head frames carrying the sheaves for the hoisting ropes. One of the most recent of these is at the Gilberton shaft, where a timber head frame had been planned, but a consideration of the question of life of steel and wooden bridges as well as the greater rigidity of the steel structure and the greater cost of maintenance of the wooden structure—due to the shrinkage of the timber and the racking strains—led the company to decide upon the steel structure. The shaft is 1100ft. deep, with four compartments, two for hoisting coal and two for water. The sheaves for the latter are placed above and in front of the former, the axles being all in line with the inclined back brace. The frame consists of a tower 20ft. 8in. square at the top and 20ft. 8in. by 27ft. at the base. From the top of this an inclined back brace extends at an angle of about 45 deg., and a continuation of this carries the bearings for the sheaves, which are 55ft. and 66½ft. above the ground and 10ft. 4in. apart. The members are built up mainly of angles and channels connected by lacing, and amply stiffened by horizontal and vertical diagonal bracing to resist the racking strains. The working load is 20 tons in each compartment of the shaft, and the two engines can raise these loads at a speed of 2300ft. per minute. The hoisting ropes are 2in. diameter, made of crucible steel wire, and these pass over 14ft. sheaves with 10in. journals. The bearings are inclined to the horizontal, so that the resultant of the live load is nearly normal to them. As one bucket is usually empty and the other loaded, the back brace has an unsymmetrical loading. To provide for this there is a system of trussing between the legs of the back brace, which efficiently distributes the stresses.

Electric light station.—The Electric Light Company of Boston has recently completed a large central power station to take the place of the several smaller stations now in operation. It is a one-storey building, 244ft. long and 174ft. wide, with two inner walls dividing the building into three parts, each running the full length of 244ft. The longest of these is the engine room, 82ft. wide, containing six direct-connected dynamos and vertical engines, with provision for six more. Then comes the boiler room, 52ft. wide, with twelve Babcock and Wilcox water-tube boilers, in six batteries. Next to this is the coal storage room, 30ft. wide. The roof is nearly flat, and is supported by steel trusses, and a travelling crane runs the length of the engine room, giving a clearance of 39ft., while the height from the floor to the roof trusses is 47½ft. The engines are of the vertical, condensing, cross compound type, with cylinders 28in. by 48in. and 56in. by 48in., developing 2400-horse power at 120 revolutions, 160 lb. of steam, and 23 per cent. cut off. The 1500-kilowatt dynamos are of the revolving field type, delivering a three-phase current of 2250 volts, without the use of rising transformers. Opposite the engines will be twenty synchronous motors of 200-horse power, each driving two arc machines of 160 lights capacity, supplying current for 5000 arc lamps. The boilers will have automatic stokers, and the Hawley down-draught furnaces. The brick chimney is 11ft. diameter inside, and 225ft. high. The walls of the coal room are formed by columns of 20in. rolled steel joists, 8ft. apart, with vertical brick arches, 20in. thick, spanning between them, thus giving great strength to resist the pressure of the coal pile. On each column is a vertical pipe composed of lengths of pipe having a bell mouth at the bottom fitting over, but not touching the end of the pipe below. This provides ample ventilation for the 9000 tons of coal, the bell preventing coal from getting into the pipes. The coal is unloaded from barges by a Hunt excavator, and delivered to the coal room by a Hunt travelling conveyor.

LAUNCHES AND TRIAL TRIPS.

MOUNTBY; built by, Messrs. William Gray and Co., Limited; to the order of, Messrs. R. Ropner and Co.; dimensions, 336ft., 47ft., 24ft. 10in.; engines, triple-expansion, 24in., 38in., 64in., by 42in., pressure 160 lb.; constructed by, Central Marine Engine Works; trial trip, December 20th.

OSBORNE; built by, Messrs. C. S. Swan and Hunter, Limited; to the order of, Messrs. Raeburn and Verel, of Glasgow; dimensions, 387ft. 6in., 48ft. by 29ft. moulded; engines, triple-expansion, 26in., 42in., 69in., by 48in., pressure 160 lb.; constructed by, Wallsend Slipway and Engineering Company, Limited; trial trip, December 22nd, 11 knots.

TWIN-SCREW steam launch; built by, Edward Hayes; to the order of, The British Government; trial trip, December 22nd.

HAICHING; built by, Messrs. David J. Dunlop and Co.; to the order of, Douglas Steamship Co., Limited; dimensions, 280ft., 38ft. by 25ft. moulded; to carry, 2200 tons, trial; engines, triple-expansion, 22in., 35in., 57in., by 39in.

ALMORA; steel cargo steamer; built by, Messrs. D. and W. Henderson and Co.; to the order of, Messrs. MacKay and MacIntyre; dimensions, 375ft., 50ft., by 28ft. 8in.; engines, triple-expansion, 25in., 41in., 67in., by 48in.; launch, December 28th.

NEWCASTLE; steel screw steamer; built by, Messrs. C. S. Swan and Hunter; to the order of, Messrs. J. J. and C. M. Forster; dimensions, 341ft., 48ft., 26ft. 6in.; to carry, 5500 tons; engines, triple-expansion, 24in., 40in., 64in., by 42in., pressure 170 lb.; constructed by, North-Eastern Marine Engineering Company, Limited; launch, December 28th.

TRUNK steamer; built by Messrs. Ropner and Sons; to the order of, Britain Steamship Company, Limited; dimensions, 316ft., 46ft. 6in., 22ft. 2in.; to carry, 4500 tons; engines, triple-expansion, 23in., 38in., 62½in., by 42in., pressure 160 lb.; constructed by, Messrs. Blair and Co.; launch, 28th December.

SVEND HAUG; screw steamer, raised quarter-deck; built by, Messrs. S. McKnight and Co., Limited; to the order of Norwegian owners; dimensions, 180ft., 29ft., 13ft.; to carry, 800 tons; engines, triple-expansion, 15in., 25in., 40in., by 27in., pressure 175 lb.; constructed by, Messrs. McKie and Baxter; trial trip, December 23rd; 10·2 knots.

THE IRON, COAL, AND GENERAL TRADES OF BIRMINGHAM, WOLVERHAMPTON, AND OTHER DISTRICTS.

(From our own Correspondent.)

THE year which has just closed in the iron trade of this district commenced with numerous encouraging signs of improvement, and with some actual advances on the prices prevailing in the latter few months of 1897. The general impression twelve months ago was that a good year's trade awaited iron, steel, and coal producers, and that before long there would be a large increase of production, with higher values of all kinds of raw material. Marked bars were quoted £7 10s., and merchant bars £6 10s. to £6 12s. 6d. The Unmarked Barmakers' Association quoted £6 2s. 6d. to £6 5s.; hoop iron was £6 5s. to £6 10s.; and gas strip £5 12s. 6d. to £5 15s. per ton. Sheets were in an unsatisfactory state, and a new Association was proposed to try and improve their condition. Black sheets, singles, were £6 2s. 6d. to £6 5s.; doubles, £6 5s. to £6 10s.; and lattens, £7 5s. to £7 10s. Galvanised corrugated sheets were a minimum of £9 10s., with an average of £9 12s. 6d., and a maximum of £9 17s. 6d., f.o.b. Liverpool.

The April quarterly meeting passed over without anything to justify the optimistic views adopted by the unmarked bar makers, who tried to advance prices, but the advance was for the most part nominal.

Prior to midsummer, owing to stronger rates for pigs, an improvement appeared, undeterred by the war between Spain and America, which at the July quarterly meetings almost attained the strength of a "revival." Selling rates were firmer in all sections of the manufactured iron market, but official quotations showed little change. The Unmarked Bar Association put up prices to £6 5s., and tube strips advanced 2s. 6d., while, owing to a curtailment in make, black sheets were also stronger by 2s 6d. per ton, and galvanised sheets by 5s. per ton. It was not, however, until September that anything like a general improvement in finished iron was established, and at the October quarterly meeting Staffordshire marked bars were advanced 10s. per ton. This was the first advance since December, 1896, and marked bars became the present price of £8, with £8 12s. 6d. as the Earl of Dudley's quotation. The advance carried with it a similar rise in hoops, sheets, and plates rolled by the "list" iron houses, the last named becoming £9 to £10. The full rise is maintained as the year closes. Indeed, as I last week stated, the probability is that next year quotations will go a further 10s. Second-grade bars went up in October to £7 10s., and merchant bars to £6 12s. 6d. and £6 15s., while common bars were again advanced 5s., making the Association minimum £6 10s., at which it still stands. Hoops and strips were advanced 5s., making the former £6 10s. to £6 15s., and the latter £6 2s. 6d. Sheets participated in the revival to the extent of an increase of 2s. 6d. to 5s. per ton, doubles becoming £6 12s. 6d. to £6 15s., and galvanised sheets advanced 10s. to 15s. per ton. The advance in galvanised sheets brought prices up to £10 15s. to £11 per ton, f.o.b. Liverpool, and was largely the result of the very much dearer prices of spelter, which has been going up for the last six months.

The South Staffordshire and Midland pig iron trade has been upheld throughout 1898 by the limited production and the low stocks. Prices have greatly improved, and in no department has the revival of the year made itself so apparent as here. It is now admitted that, notwithstanding the advance in coal prices, pig iron can now be again made at a profit. Prices of all classes of metal are, it is calculated, higher now than they have been during the last seven years. This is particularly so with regard to foundry iron. Staffordshire cold blast iron, which in January last was sold at £4 10s. to £4 12s. 6d., is now quoted £5. Best forge pig metal sold in January at £2 17s. 6d. or less, is selling at date at £3 2s. 6d. to £3 5s., while still better figures are anticipated at the new year quarterly meetings. Medium and common pig iron at £2 7s. 6d. and £2 5s. respectively show very satisfactory advances compared with the prices of twelve months ago.

Derbyshire and Northampton smelters are now realising about 5s. to 6s. per ton advance over the January prices for forge pigs, while foundry numbers have advanced 8s. to 10s., and on some brands even 12s. 6d. per ton. Even at these enhanced values buyers are more anxious than sellers to close contracts for 1899 supplies. Surprise is expressed that with such an encouraging outlook smelters do not blow in more furnaces, but with few exceptions it appears that none of the idle furnaces are being got ready for re-starting.

Local pig makers have now a fresh competitor to face, owing to the increasing sales of American pig iron in this district. According to the report of the American Consul in Birmingham, American pig iron is now coming into Staffordshire to the extent of about 2000 tons per month—the output of iron from the local furnaces being about 25,000 tons per month. The Consul remarks that the recent rise in the American iron and steel market shows that "even when Alabama pig iron is higher than British native brands, it can still find an English market, and that its place here is permanent."

NOTES FROM LANCASHIRE.

(From our own Correspondents.)

Manchester.—Generally the engineering trades of this district close the year in a more satisfactory position than they have held for a very considerable time past. With the exception that some branches of the machine-making trade are not very actively engaged, and here and there small engineering firms that are not up to date have to struggle on with only a comparatively small weight of business, there are very few establishments of any note that have not on their books orders sufficient to keep them going well over the ensuing year, and in many instances where new work is offered it can only be entertained on the condition that customers are prepared to wait six or nine months before it can be put in hand. This exceptional pressure of work is necessarily compelling customers who are not in a position to wait to seek elsewhere for prompt execution of their orders, and this has been recently very noticeable in connection with the locomotive building trade, some of the home railways having been compelled to place their orders in America, and to a lesser degree the same remark also applies to some of the special branches of machine tool making. Throughout practically all branches of the Lancashire engineering trades the outlook for the ensuing year is one of continued exceptional activity. The opening of the year was, however, not at all so satisfactory as the close. The failure of all efforts to bring about an amicable settlement of the protracted dispute was being followed by a large extension of the lock-out, and for the moment the prospect was gloomy in the extreme. The struggle was, however, rapidly wearing itself out, and although it was not until the end of January that the settlement finally came, and not for another month could it be said that works had again got into full operation, the succeeding portion of the year has been one of almost unprecedented activity for practically every branch of engineering industry.

For a month or so following the settlement of the engineering dispute most of the works throughout Lancashire were going at full swing, finishing as rapidly as possible the orders they had been able to proceed with partially during the stoppage, and for a time comparatively little new work could be booked. A heavy accumulation of orders held in abeyance during the strike was, however, waiting, and pressing to be put in hand, whilst the revival of trade and industrial enterprise all through the country brought forward further large requirements for all descriptions of machine tools and general engineering plant, which very speedily filled up the books of all the principal firms, not only over the remainder of the year, but far into the succeeding twelve months.

The machine tool making trade, in which Lancashire holds a foremost position, has not for a long period experienced so great a pressure of work, both in the light and heavy departments, and the situation has been very much the same throughout all the leading engineering industries of the district. The boilermaking trade, of which Lancashire is perhaps the most important centre in the kingdom, has never before been so busy; the locomotive building trade, although not now so important a branch of industry in this district as formerly, has secured an almost unprecedented quantity of both home and foreign work, that has filled up the shops right on until the end of next year. Builders of both steam and gas stationary engines of all descriptions have been exceptionally well supplied with orders, and in most cases close the year with their books well filled for some time ahead.

The enormous development of electricity in its application to lighting and for motive power has necessarily given a great stimulus to electrical engineering in all its branches, many of the Lancashire works being quite unable to keep up with the pressure of orders they have had to meet. In hydraulic engineering there has been considerably more than the average activity, and this also applies to the numerous smaller general branches of engineering. The machine-making trades have also generally passed through an exceptionally prosperous year, although some of the loom-making branches have experienced a slackening off towards the close.

With this almost unprecedented activity, extensions and reorganisations of works have been pushed forward in all directions, and a noticeable feature has been the increased attention paid to electricity as a motive power, not only for crane work, where it is rapidly supplanting the old methods, but as a motive power for driving all the general tools and plant of large engineering establishments, one important local works having adopted electricity exclusively both for lighting and driving, whilst at several other large works in the district arrangements on similar lines are at present in progress.

The shipbuilding trades on the Mersey have not experienced the exceptional activity which has characterised other branches of engineering. This is in striking contrast with the position at Barrow, where the records of all previous years have been beaten, and, in fact, with the shipbuilding trades throughout other parts of the county, where the pressure of work has been the greatest ever known. One builder reports that owing to combinations of workmen, and the action of the Mersey Docks and Harbour Board, the trade has become almost extinct, and he quotes in contrast the example of German and French ports, where, he says, everything is done to increase this and kindred trades.

Messrs. Laird Bros. have only launched two vessels during the year, viz., H.M.S. Orwell, a torpedo boat destroyer of 320 tons, 6000 indicated horse-power, and a speed of thirty knots, and the Princess of Wales, a steel paddle steamer of 1009 tons, and a speed of nineteen knots, but the firm have also had in progress the following:—H.M. first-class battleship Glory, which they hope to float during the spring of 1899; H.M. destroyer Express, now undergoing preliminary trials; H.M. sloops Mutine and Rinaldo, of 960 tons displacement and 1400-horse power, which are now in frame; a fast paddle steamer—for a cross-Channel service—of 1440 tons displacement and 5500-horse power; and a 30-knot torpedo boat destroyer for a foreign Government, both of the two last-named vessels being in an early stage of construction.

On the Liverpool side of the Mersey, Messrs. W. H. Potter and Sons have launched a British man of war, the Bramble, a steel twin-screw vessel, sheathed with wood, of 1300-horse power; also a steam steel yacht, Skipjack, for Sir Richard Williams Bulkeley. Messrs. John Jones have turned out eighteen steamers of small dimensions—the total tonnage being 1857—fifteen of which are paddle steamers for passenger purposes, and the other three screw steamers. Messrs. James Harland and Co. have launched a composite sailing craft to carry forty tons for a London gunpowder manufacturing company. Other firms report that they have only done repair work during the year.

In connection with the engineering trades a noticeable feature has been the absence, following upon the settlement of the engineering dispute, of any serious friction between the employers and the workmen on labour or wages questions. From time to time, as could only be expected during a period of such unprecedented prosperity, questions of hours, wages, or shop regulations have been brought to the front by the workmen, but these have been invariably amicably settled by reference to the executive authorities representing the federated employers and the operators, in accordance with the agreement arrived at in January last; and for the trade to have gone through with absolute quietude the great pressure of activity of the past eleven months encourages the hope of a better relationship between capital and labour than has previously existed. In fact, a prominent official of the Amalgamated Society of Engineers has very candidly expressed his opinion that the relations at present prevailing between the employers and the employed are much more satisfactory than was anticipated in the early part of the present year, when the compromise was effected after a prolonged conference between representatives of the federated employers and the joint trade unions. Indeed, he went so far as to admit that the Employers' Federation had proved an actual benefit to the workmen, as the Engineering Federation had even protected the interests of the operatives where they had been threatened by unscrupulous employers. With such an admission from a representative of the workmen, it is not surprising that work generally

is going on smoothly, and that even the trade union representatives regard as improbable the occurrence of any serious hitch in there future relations with the federated employers.

Throughout the iron and steel trades of this district the retrospect generally is satisfactory. The year opened with a fairly steady tone, but the resumption of operations at engineering works at the end of January did not bring about that increase in the weight of buying that had been expected. In fact, it was not until about the turn of the half-year that a really material improvement in the position was established. During the lock-out and strike most of the large establishments had been able to keep in progress their rough, heavy work, on which the chief weight of material was required, and for some time after the settlement they were engaged mainly in finishing operations, for which comparatively small quantities of material were necessary. As a consequence, during the first three or four months of the year instead of the anticipated rush of buying, there was only a moderate demand for pig iron, and prices, which had begun to harden, in some instances receded 1s. to 2s. per ton. The general tone, however, was one of confidence as to the future, as already indications were manifest of exceptional activity throughout all the principal iron-using industries, and although no actual "boom" was looked for, a large demand upon all classes of material was anticipated, with a steady upward move in values. With the turn of the half-year these anticipations began to be realised, and a decided improvement set in, with a strong advance in prices, which was maintained right on to the close. For a time buyers were cautious about following the upward move, but makers generally had their books so well filled that they were in a position to be quite indifferent as to business except at their full rates, and, in fact, were in many cases so heavily sold that they were unable to entertain new orders except for deferred delivery. During the second half of the year prices, which had previously stiffened up in most cases about 1s. per ton, advanced 3s. 6d. to 4s. for Lancashire, 4s. to 5s. for Lincolnshire and Derbyshire, about 6s. on Middlesbrough, and 5s. upon Scotch and ordinary brands of American pig iron coming into this district. With the close of the year there has been some disposition to question whether prices have not touched their maximum, with here and there some slight underselling; but this by no means represents the prevailing opinion, which is rather that, with no slackening off in actual consumption and the increased cost caused by the upward move in fuel, the tendency of prices is more likely to be in an upward than in a downward direction. Certainly makers are in the position that for a considerable time ahead they will be under no necessity whatever to seek for business at all, and at present they are mostly so heavily sold to their regular customers that they have little or no iron to offer for anything like early delivery. Lancashire makers have their books so full that they are really not sellers in the open market, and their quotations, which are firm at about 51s. for forge, to 53s. 6d. for foundry, less 2½, delivered Manchester, are scarcely more than nominal. Much the same applies to both Lincolnshire and Derbyshire brands. Nominally list rates are unchanged on the basis of 48s. to 48s. 6d. for forge, and 51s. 6d. to 52s. for foundry, Lincolnshire, and 53s. 6d. to 54s. 6d. for foundry, Derbyshire, net cash, delivered Manchester; but makers in most cases prefer not to quote at all just at present, this being especially the case with regard to forge iron, considerable offers of which have either been declined, or only partially entertained, and, in some instances, quotations which were given recently have been altogether withdrawn, owing to anticipations of higher prices next year. Makers of Middlesbrough iron are firm at prices considerably above those at which ordinary G.M.B.'s could be bought in the open market. Good named brands are quoted 53s. 10d. net, with G.M.B.'s obtainable at 52s. 10d., delivered by rail Manchester. A rather stronger tone is noticeable in Scotch iron, Glengarnock averaging 55s., and Eglinton 55s. 6d. net prompt cash, whilst American brands range from 50s. up to 52s. net, delivered Manchester docks.

The finished iron trade has followed much the same course as pig iron, the tendency all through the year having been in the direction of improvement, which has resulted in a gradual upward move in prices, representing an advance of 17s. 6d. in bars, 10s. in hoops, and about 5s. to 7s. 6d. in sheets. Makers close the year with their books well filled with orders for bars, and the full advance in prices not only readily got, but in some instances they are declining to entertain further business of any large quantity at current rates, whilst they are generally not in a position to commence deliveries on new orders until about the second month in next year. Lancashire bars are firm at the full basis price of £6 10s., with £6 12s. 6d. as a quotation on special orders, and North Staffordshire qualities exceedingly firm at £6 15s. as the minimum delivered here. Hoops are not in quite so strong a position, a good deal of the export trade, especially to South America and the Colonies, having been taken by competitors from the United States, but local makers hold firmly to their association list rates of £7 for random to £7 5s. for special cut lengths, delivered Manchester district, and 2s. 6d. less for shipment. Sheets also close the year only in moderate request, at about £7 5s., delivered here.

The exceptional industrial activity of the past year has perhaps made itself even more manifest in the steel trade than in the iron trade, and for both raw and manufactured material there has been so great a pressure of demand that eventually it has become less a question of prices than of obtaining deliveries of material from makers and manufacturers. The advance in prices, which was earlier in definitely asserting itself than in the iron trade, has been somewhat extraordinary, raw material having risen quite 10s. per ton, whilst some descriptions of manufactured material, such as plates, have advanced £2 per ton during the twelve months. The almost unprecedented activity in the shipbuilding and boiler-making trades, both very large users of steel, and the great weight of structural work going on in various directions has necessarily brought on the market enormous requirements for finished steel, and this has necessarily involved a great consumption of raw material, the demand for both steadily increasing as the year progressed, and makers of steel plates in some cases close the year so heavily sold that they are not in a position to book new orders on which they can promise delivery before June next. The closing prices of the year are all exceedingly strong at 65s. 6d. to 66s. 6d., less 2½, for hematites; £4 15s. net cash for local steel billets; £7 to £7 7s. 6d. and £7 10s. for steel bars; £7 15s. for common steel plates; and £8 5s. to £8 7s. 6d. for boiler-plates, delivered in the Manchester district.

In the coal trade, although it has scarcely participated to a corresponding extent in the very decided improvement which has come over other branches of industry, there has been a substantial upward move in prices, and the year, taking it all through, has been a very satisfactory one. During the earlier part, however, the outlook was not encouraging. There was a prospect of heavy accumulations of stock, and possibly lower prices. The protracted strike in South Wales, however, altogether altered the situation, and not only completely cleared away all surplus supplies, but kept the pits on full time during the summer, and gave a permanent hardening tendency to prices. House-fire qualities have experienced an advance of about 1s. to 1s. 3d. per ton, and renewals of contracts have only been accepted at a substantial advance on the low prices that had to be taken last year. All other descriptions of fuel have met with a steadily increasing demand throughout the year, with a gradual hardening up in prices. The lower qualities of round coal for steam and forge purposes have advanced 1s. to 1s. 6d. per ton, and on engine classes of fuel there has been an upward move of about 1s. to 1s. 3d., the latter class of fuel being with the close of the year exceedingly scarce, and special prices obtainable where anything like pressing new business comes forward. The important locomotive and gas coal contracts have also been placed on more advantageous terms for colliery owners, who, with the exceptional conditions brought about by the South Wales dispute, were enabled to take up a strong position when inquiries for these contracts came upon the market. The principal railway companies hesitated some time about placing their contracts at the advanced rates which the Lancashire coalowners were demanding, but they were eventually settled at an advance of 9d. per ton over the prices paid last year. On gas coal contracts, for which prices were somewhat irregular last year, there was a general levelling up to the maximum rates that had been obtainable the previous season, with here and there further advances of 3d. to 6d. per ton. With the close of the year there has been an all-round improvement in the coal trade, with a strong upward tendency in prices, and an official upward move on the 1st of January has been practically decided upon by the leading collieries throughout Lancashire. The better qualities of round coal, suitable for house-fire purposes, although in perhaps less request than other descriptions of fuel, are generally moving away freely, the demand not only taking off all the output of the collieries running full time, but stocks are being filled up to a moderate extent to meet requirements. Prices at present remain without quotable change, but exceedingly firm at 11s. to 11s. 6d. for best Wigan Arley, 9s. 6d. to 10s. 6d. for Pemberton 4ft. and seconds Arley, and 8s. to 8s. 6d. for common house coal at the pit mouth. Common round coals continue in very brisk request for ironmaking, steam, and general manufacturing purposes, collieries in many cases being barely able to keep up with the requirements of their customers, and prices are decidedly stronger, especially for forward delivery. Current quotations on inland sales average about 7s. 9d. to 8s. 3d. for good qualities of steam coal at the pit mouth, but collieries would scarcely be disposed to enter into anything like long forward contracts without quoting advances on these figures. For engine classes of fuel there is a continued and increasing pressure of demand, and where new business is offered buyers find it exceedingly difficult to place orders for any quantity. Even where collieries, which are mostly so heavily sold to their regular customers that they have practically little or nothing to offer, do entertain business from new customers, it is only at prices above current rates, and generally there is a hardening upon recent quotations, common sorts of slack fetching 4s. to 4s. 6d.; and better qualities 5s. to 5s. 6d., at the pit mouth.

The shipping trade during the first three months of the year was only in a moderate condition, but with the commencement of the South Wales dispute there was a rush of orders on the market, and a prompt rise in prices of 2s. 6d. per ton, with advances of 5s. quoted in some cases for special supplies, whilst on the ordinary shipping business rates were put up 1s. to 1s. 6d. per ton. During the ensuing four or five months the shipping trade fluctuated considerably, but substantial advances were readily got. With the termination of the dispute prices quickly returned to something like their normal position, with a moderate business doing, and close the year about 1s. to 1s. 6d. higher than the rates ruling in January, and averaging 9s. 6d. to 10s. per ton, delivered at the Mersey ports.

Barrow.—The holidays have been generally observed in this district, but a good business has been done by commercial men, and, of course, the forty-one furnaces blowing have been kept in full blast, so that the make has been maintained. In the Barrow district the effect has been to increase stocks, owing to the stoppage of the steel works for a fortnight, while in West Cumberland iron smelters who are also steel makers have been stocking pig iron in their own yards in order to have supplies available next year. During the week stocks have increased 2673 tons, and now stand at 176,220 tons. Business in warrant iron has been on a large scale, and while a large tonnage has gone into stock, there has been a considerable clearance at the same time, and this clearance will probably be shown to be greater next year when the steel works are again in full operation. Prices are very steady at 57s. 6d. to 58s. per ton, net f.o.b., for mixed Bessemer numbers, and warrant iron is steady at 57s. 2½d. net cash, sellers; 57s. 2d. buyers.

Iron ore is in larger production, and as the demand is very fully and very briskly maintained, and as there is need of a fuller supply of raw material by smelters in the district, efforts are being concentrated in the direction of developing new discoveries of ore, one of which at Alcoats, in the Cleator district, is spoken of as important, embodying a large bulk of metal of good quality. The market price of good ordinary ore is 14s. per ton net at mines, best descriptions being at 17s. 6d., and common sorts at 11s.

Steel makers have a very good outlook in every department of their business, and are already very well off for orders. This is particularly the case in reference to steel shipbuilding material, which is in very heavy consumption, and which is likely to increase in the near future. Prices are steady at £6 17s. for heavy steel plates for shipbuilding purposes. A good trade is noted in thin plates. Business in rails is very satisfactory, and although the trade doing is chiefly in heavy sections, it is known that light rails and tram sections have frequently engaged the attention of makers. The trade doing in billets, tin bars, hoops, merchant steel, steel props, &c., is brisk, and heavy steel castings remain in very full demand.

Shipbuilders and marine engineers are on holidays at present, but are nevertheless on the look-out for new and important business, and prospects are decidedly good. The work in hand is considerable, and much progress is being made with it.

The coal and coke trades are very steadily employed, and prices are firm.

Owing to the holidays, the usual weekly returns of shipping exports are not to hand, but the tonnage of pig iron and steel over last year shows a very marked increase, and prospects are that further decided increases will be made at an early date. Freights remain very good and remunerative.

THE SHEFFIELD DISTRICT.

(From our own Correspondent.)

THROUGH the extreme pressure of work in the heavy departments, the holidays this season have been considerably curtailed.

In the colliery districts efforts were made to get the miners back to work on the 28th inst., and in some instances the men readily responded. Generally, however, the collieries were not re-opened until the 29th inst., in spite of the deplorably wet weather, which prevented the playtime being as fully enjoyed as it otherwise would have been.

The year will open with a firmer tendency in prices. Railway contracts for the half-year commencing in January must now be pretty nearly completed, but so far the results have not been made public. It is expected, however, that the advance to be paid for supplies will range from 6d. to 9d. per ton. Values all round are stiffening. In house coal a spell of frosty weather would instantly send quotations higher. At the time of writing prices are as quoted last week. Best silkstones make 9s. to 10s. per ton; ordinary fetch from 7s. 6d. per ton; Barnsley house, 8s. to 9s. per ton; seconds, from 7s. per ton. Steam coal continues to be in remarkably good request, considering the season of the year. A very fair tonnage is still being sent to the Humber ports, while the railway companies are having full deliveries, and the inland trade is well kept up. Contracts for forward deliveries are only taken on terms in advance of the contracts now expiring. Barnsley hards make 8s. to 8s. 6d. per ton; seconds from 7s. per ton. For gas coal the demand is in excess of the supply, while manufacturing fuel is greatly helped by the improved values obtained for the smaller sorts of fuel, which is in abnormal request for coking and ordinary firing purposes. Quotations:—Nuts, 6s. 6d. to 7s. per ton; screened slack from 5s. per ton; pit slack from 3s. per ton. Best washed coke is at 11s. to 12s. per ton; ordinary, 10s. to 10s. 6d. per ton.

The year will open with abundance of work in the establishments devoted to military, marine, and railway material, as well as in those concerned with edge tools, light and heavy, engineering, boilermaking, &c. A good deal of complaint is heard about the difficulty of obtaining British-made tools, and for the moment the American make appears to be holding the field against both the home and the German manufacturer. In the lighter branches the outlook is not so bright in certain cutlery departments, which have been adversely affected in the Spanish, American, Cuban, and Philippine markets by the recent war.

NORTH OF ENGLAND.

(From our own Correspondent.)

THE usual Christmastide quietness has overspread the trade, so far as regards buying; but this is a matter of small moment to the producers, as they are so well supplied with orders, and are carrying on operations at their works much more regularly than at this season for many years. Very short holidays have been the rule at manufactured iron and steel works shipyards, engineering establishments, &c.; but it has been rather difficult to get the men back, as they have earned so much lately. Prices in all branches are well maintained, and any changes can hardly be otherwise than in an upward direction.

Makers have this week been asking 44s. 6d. per ton for prompt f.o.b. deliveries of No. 3 Cleveland G.M.B. pig iron, but a few sales have been made by second hands at 44s. 3d. Buyers do not hesitate to offer 44s. 6d. per ton for forward deliveries of No. 3, and this is an encouraging sign for the future. No one, indeed, looks for lower prices. No. 4 foundry realises 44s., and grey forge is at 42s., which is a comparatively low price, seeing that if it bore its usual proportion to Nos. 3 and 4 foundry it should be at 43s. 6d. But there is rather too much forge iron made, especially this week, as the blast furnacemen attend rather badly as a rule to their work, and the furnaces are fed irregularly, so they cannot give good results. Prior to the general introduction of the eight hours' system a year ago the Cleveland ironmasters each Christmas made a present of half-a-crown to those who did not neglect their work during the week, but the employers did not see their way to continue to offer this inducement when they granted the concession of the three-shift day, as that was permanently increasing the cost of producing pig iron by at least 6d. per ton. It cannot be said that the introduction of the eight hours has led the men to work more dilligently; in fact, more forge quality iron has been made than formerly, and the price cannot so well be kept up as foundry iron. Mixed numbers of East Coast hematite pig iron are quoted at 55s. 6d., and only in odd cases will 55s. now be taken.

Prices of manufactured iron and steel are very firm, and consumers are keener to do business than producers—indeed, the latter are rather indifferent, as they are so well booked ahead. The steel millmen at the Consett Works will have their wages for the next quarter advanced 2½ per cent., the official accountant to the Conciliation Board having ascertained that the realised prices of steel plates have advanced enough during the three months ending November 30th to justify this.

Messrs. Head, Wrightson, and Co., Teesdale Iron and Engineering Works, Thornaby-on-Tees, have secured a considerable contract for bridgework from the Egyptian War-office, in connection with the extension of the military line to Khartoum. Altogether eighteen bridges are to be supplied. The same firm furnished materials for the bridges required on the portion of the line already constructed. To them has also been given an order for the cast iron piles for the extensive irrigation works on the Nile at Assiout.

The Spanish War Department have decided on putting down at Trubia a mill for rolling steel plates, and the drawings for this will have been prepared by Messrs. Jeremiah Head and Sons, of London and Middlesbrough, who have received instructions from the Director of the Royal Arsenal at Trubia. The execution of the work has been entrusted to Messrs. Lamberton and Co., of Coatbridge, N.B.

A retrospect of the iron and allied industries of this district for 1898 cannot but be regarded as satisfactory; such a prosperous and busy year has probably never been experienced in most branches, and it is hardly possible to find a department which has not done better this year than it has been during the last seven years at least. But, good as trade has been this year, manufacturers expect that next year will be better. If, however, we examine the statistics of the exports of iron and steel, there will be found no evidence of the excellence of the trade that has been done, because shipments have fallen off very materially as compared with 1897, and in some branches they have not come up to the figures of 1896, though they are much above those of any year previous to that. The shipments this year, however, cannot, as they usually are, be taken as a criterion of the general prosperity, for the brisk business has not been done on foreign account, but on home account, and any shortcoming in the former has more than been made up for by the activity in the latter. Indeed, it is the extraordinary home trade that has led to the smaller business with the foreigner. Our producers have made no special efforts to cultivate the foreign trade when they could get so many orders from home consumers, and, moreover, could secure better prices at home than the foreigners were prepared to give. The very busy year in the iron and steel trades has been mainly brought about by the unprecedentedly active condition of the shipbuilding industry, an activity which promises to be continued during next year, so that manufacturers look forward to the future with confidence.

Cleveland, which raises 41 per cent. of all the iron ore produced at the mines in the United Kingdom, during 1898 is estimated to have supplied 5,600,000, as compared with 5,679,153 tons in 1897, and miners' wages have been advanced 3¾ per cent., making 11½ per cent. rise since the upward movement commenced four years ago. The imports of foreign ore are small, much less than the activity of the steel trade and the heavy consumption of hematite iron would lead any one to believe. It is stated that the makers have been drawing a good deal on their stocks of ore. Into the Tees only 1,160,000 tons of ore have been imported, as compared with 1,193,316 tons in 1897. In 1895 as much as 1,574,000 tons were received. The prices of Rubio ore have varied between 14s. and 15s. per ton delivered. The ore merchants have had a rather bad year, because freights have been higher than they counted on, and contracts have frequently been hardly profitable on this account.

Makers of pig iron in the North of England have had an excellent year, and their output will be something like 3,100,000 tons, as compared with 3,197,641 tons in 1897, and 3,211,926 tons, these three being by far the best years that the ironmasters of this district have ever experienced, so far as regards the volume of their trade. About half the above-named output consisted of ordinary Cleveland iron, the remainder being made up of basic, hematite, and spiegel iron. Out of the 125 furnaces in the North of England the average number in blast has been 95. Of the 86 Middlesbrough furnaces, 67 have been in operation. No figures are available to indicate how much stock pig iron makers held, but Connal's stock of Cleveland iron, which declined 84,000 tons in 1897, has increased about 58,000 tons in 1898, and now is about 137,000 tons. Their stock of hematite pig iron, which was reduced about 80,000 tons in 1897, has in 1898 further declined about 17,000 tons, and now is just over 34,000 tons.

The shipments of pig iron from the Cleveland district will reach 1,115,000 tons, this being 10 per cent. less than in 1897, but they are above those of any previous year. The decrease has been due to the falling in shipments over sea, these having been short of those of 1897 by 16 per cent., whereas coastwise deliveries have only declined 2½ per cent. The reason for the smaller business with foreign countries is that our home trade has been so extensive. Very considerable decreases are shown to Germany, Holland, Belgium, and France, but it must be borne in mind that they were in 1897 phenomenally large to these particular countries, owing

the short supplies of coke for the furnaces in these countries. The quotations for No. 3 Cleveland G.M.B. pig iron have varied between 40s. and 48s., and the average has been 42s., which is 1s. 10d. better than in 1897, and is above everything that has been reported since 1890. Cleveland warrants have had a range in price of from 39s. 9d. to 52s., and close the year at about 44s. 6d. Up to the end of September a better price than 43s. 6d. had not been seen. Then there ensued the "rig" in Cleveland warrants, which continued over October and November, and caused a rapid advance of prices, such as has not been witnessed for nearly ten years.

The realised prices of manufactured iron and steel have improved, though as yet to nothing like the extent that has been reported in connection with quoted rates, for the great advances in the latter have been during the autumn months chiefly, and the result upon the realised prices will not be apparent until the returns are issued about the end of January. So far as the particulars are available, it is apparent that the average realised price of manufactured iron has been about £5 4s. 10d., or 3s. more than in 1897, and nearly 10s. more than in 1895, which was the year of lowest prices for manufactured iron. Quoted prices have gone up with a rush during the last three months, and the year closes with them at their best. Steel and iron plates have risen 27s. 6d. during the year; steel angles, 25s.; iron angles, 22s. 6d.; iron bars, 20s.; sheets, 20s.; and rails, 2s. 6d. Wages at the finished iron mills and forges have advanced 2½ per cent. during the year; smelters at the steel works have had their rates raised 10 per cent., and the millmen at the steel works 2½ per cent., but 2½ per cent. more is to be given, to commence January 2nd.

The exports of manufactured iron and steel from the Tees have only reached 431,000 tons, as compared with 558,721 tons in 1897, a decrease of about 20 per cent., but taking the oversea trade alone, there has been a falling off of no less than 28 per cent. But the activity of the home trade fully makes up for this. The North-East Coast shipbuilders have launched 849,447 tons of new vessels, this being 295,217 tons more than in 1897, and it is by far the largest tonnage ever reported, each centre of the trade likewise reporting a record output. The marine engineers have supplied engines with an aggregate indicated horse-power of nearly 480,000, and nearly all the firms have had to run their establishments night and day, the arrears of work being so large in the early part of the year, owing to the six months' strike of engineers which terminated in January, 1897.

NOTES FROM SCOTLAND.

(From our own Correspondent.)

THERE has been very little business in the iron market this week, for although Christmas is not observed to the same extent as in the South, the season has come to be more of a holiday one in recent times. The Iron Exchange was shut on Monday, and business will be again suspended for the New Year holidays from Friday till Tuesday next. The speculative element is largely out of the market at present, so that prices are comparatively steady. Consumers have not been purchasing iron to any great extent. It is reported that in a number of cases they have secured supplies well forward. As a consequence, the makers have good orders on their books, and will be able to commence the New Year in a satisfactory manner.

A moderate business has been done in warrants, the fluctuations being within narrow limits. Scotch warrants have sold from 49s. 4½d. to 49s. 6d. cash, and 49s. 8d. to 49s. 8½d. one month. There has been little or nothing doing in Cleveland warrants. Cumberland hematite warrants have sold in small quantity from 57s. 2d. to 57s. 2½d. cash, and 57s. 3d. to 57s. 6½d. one month.

Prices of Scotch makers' iron are as follows:—Govan and Monkland, f.o.b. at Glasgow, Nos. 1, 50s. 1½d.; Nos. 3, 49s. 4½d.; Wishaw and Carnbroe, Nos. 1, 50s. 3d.; Nos. 3, 49s. 6d.; Clyde, No. 1, 55s. 6d.; No. 3, 50s. 6d.; Summerlee, No. 1, 57s.; No. 3, 51s. 6d.; Gartsherrie and Shotts, Nos. 1, 56s.; Nos. 3, 51s., Calder, No. 1, 57s.; No. 3, 51s.; Coltness, No. 1, 58s.; No. 3, 51s. 6d.; Glengarnock at Ardrossan, No. 1, 55s.; No. 3, 50s.; Dalmellington at Ayr, No. 1, 51s. 6d.; No. 3, 50s.; Eglinton at Ardrossan or Troon, No. 1, 52s.; No. 3, 50s. 6d.; Carron at Grangemouth, No. 1, 57s.; No. 3, 51s. 6d. per ton.

The shipments of pig iron from Scottish ports in the past week have been 3316 tons, compared with 2819 in the corresponding week of last year. To South America 100 were despatched; India, 130; Australia, 150; France, 60; Italy, 125; Germany, 405; Russia, 100; Holland, 100; Belgium, 80; Spain and Portugal, 100; China and Japan, 100; other countries, 207; the coastwise shipments being 1639, compared with 1550 tons in the corresponding week of last year.

It is reported that consumers of Cleveland pig iron have been able to effect purchases from makers on somewhat easier terms than those at which this iron was obtainable during the recent "corner." North of England hematite is also a little easier, and the increase of stocks has much to do with the change in both cases. At the moment the inquiry for Scotch hematite pigs is slow, but the price is steady, merchants still quoting 60s. 6d. per ton for delivery at the steel works.

At Coltness Ironworks one furnace has been changed from ordinary to hematite iron. There are now 49 making hematite, 29 ordinary, and four basic iron, the total of 82 comparing with 81 at this time last year.

The malleable iron and steel branches are finishing the year under very favourable auspices. The output of mild steel has undoubtedly been the greatest in the history of the trade. All the works have been taxed to their utmost to meet the demand, and the work on hand and in prospect will keep this industry busy during 1899. Prices of mild steel goods have advanced in the past year 30s. to 40s. per ton, but there has, at the same time, been a large increase in the cost of raw material and fuel, so that profits have been made, such as they are, rather on the extensive output than the rise in price. Users of steel goods have been affected by similar conditions; while extremely busy, in many instances costs have advanced very materially.

The coal trade has been active since last report, but there will be less doing in the next week or two, as the collieries will be closed a part of next week. The past week's coal shipments from Scottish ports amount to 158,215 tons, compared with 149,505 tons in the preceding week, and 166,756 tons in the corresponding week of last year. The entire coal shipments for the year have been rather over 10,000,000 tons, and exceed those of 1897 by about 1,800,000 tons. A considerable portion of this increase is, of course, the result of the prolonged strike in Wales, which diverted a large number of orders to Scotland; but the belief is at the same time strongly held that a permanent addition of no small importance has been made to the business in coals. Prices are 1s. 6d. to 2s. 3d. per ton, according to the quality, than they were at the end of last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

MY suggestion last week that the unprecedentedly high total of 400,000 tons coal exports at the Cardiff ports would be reached Christmas week was fully realised. In this great total, as might be expected, Barry played a conspicuous part; every available tip was in full work, and a record total of 180,000 tons was reached. Wednesday shipments were the largest known for a single day. All tips in No. 1 and the six in No. 2 were busily engaged. The remaining five tips in No. 2 are now being rapidly pushed forward. Dock No. 4 excavations are also commenced.

As it is matter of general interest to locate the destinations of the present immense coal output, I note a few particulars of the busiest days at Cardiff. On the 21st, 4500 tons went to Bombay, large cargoes to Rio and the West Indies and over 12,000 tons to France. On the 22nd, 4700 tons to Colombo, 4200 tons to Ancona, 8000 tons to France, 4900 tons to Genoa, and large consignments to Malta and Constantinople. Saturday's shipments included 3400 tons to Teneriffe, 4000 tons to Marseilles, 4100 tons to Monte Video, 3700 tons to Port Said, and a large number varying from 2000 upwards. This week brought about the usual holiday reaction and deserted offices.

It was reported on 'Change, Cardiff, Monday, that new business in the steam coal trade, owing to the scarcity of the commodity, was of a restricted character, but that inquiries for forward shipment were very numerous, and that as stems for loading in January were already well filled, prices for this class of business were already quoted with great firmness. For small steam, prices, owing to the heavy requirements for ships' bunkers, were very strong, and towards the close of the week special sorts reached the high figure of 7s. 6d. per ton. At all ports extreme activity characterised business last week, Newport touching the high figure of 82,935 tons foreign, and 25,195 tons coastwise.

Swansea exhibited great activity throughout the week, especially in coal business. The Birchgrove, Four-foot, Old Pit, and others, were exceptionally brisk. Even at Tygwylit, where there had been the mischance of a broken winding rope, by great effort repairs were completed, and the colliery by Monday was in full operation. In coal exports, including patent fuel, the unusual total of 73,520 tons was reached. France, as usual, took nearly a third, namely, 23,666 tons, Italy followed with 10,190 tons; Germany, 34,370 tons; Sweden, 4250 tons; Beyrout, 1300 tons; United States, 2365 tons; and home ports, 12,000 tons. One of the old totals of patent fuel was reached, namely, 12,100 tons, Algeria and Brazil taking half the total.

The latest prices obtainable are as follows, but, as might be expected, the attendance on 'Change up to mid-week has been very limited, and a holiday character prevailed, only pressing business being undertaken:—Steam coal, best, 13s. to 13s. 6d.; seconds, 11s. to 12s. 3d.; drys, 10s. 6d. to 10s. 9d. Special smalls, 7s. to 7s. 6d.; best ordinary, 6s. to 6s. 3d.; seconds, 5s. to 5s. 6d.; and inferior from 4s. 6d. per ton. Best Monmouthshire, semi-bituminous, 10s. 9d. to 11s. 3d.; seconds, 9s. 9d. to 10s. Best house coal, 13s. to 14s.; No. 3 Rhondda, 12s. 6d. to 13s.; No. 2 Rhondda, 9s. to 9s. 3d.; special foundry coke, 24s. 6d. to 25s.; foundry, 19s. to 19s. 6d.; furnace, 16s. to 17s., all f.o.b. cash, less 2½. Patent fuel as per last quotation.

Swansea quotations:—Anthracite, steam, and bituminous unchanged, but firm. Tendency of the market upward, but is expected to be more distinctive in character next week.

A valuable addition to the stock of the premier coals of Wales was made a few days ago by the successful sinking of Messrs. Hepperfield and Williams at Bargoed. The coal won is the Mynyddyslwyn, and the thickness 2ft. 8in.

I have pointed out in this column on one or two occasions the scope for fresh industries in several of the wild districts in Wales, one in particular near Tregaron in Cardiganshire, where there is a boggy extent, called a Cors, of 3000 acres. There are many of these tracts which now only yield peat to the cottagers, but the experiments now initiated near Tregaron promise well, especially if aided by railway enterprise. Lately a beginning has been made under a patent in making briquettes, and extracting oil, and reports are hopeful. It is stated that lubricating oil, naphtha, ammonia, paraffin wax, and tar, have been won, also several bye-products. The district is near the old collegiate institution of Ystrad Meyric, and is accessible by the Manchester and Milford Railway from Carmarthen and Aberystwith.

The rail exports of the past week included 1256 tons of rails for Alexandria, and 600 tons of iron from Cardiff for Hamburg. From Newport 230 tons rails to Highbridge. Ebbw Vale has been occupied in turning out rails, &c., for the Soudan, and Bristol as well as Cardiff are enumerated in the list of quarters aiding with materials, machinery, and plant for Nile irrigating works. The inclusion of Cardiff I have not been able to confirm. The chief iron and steel works were full of pressure up to the verge of the holidays, and judging from the indication on all sides, they have had but a brief rest. On Tuesday a good deal of business was being done, and by mid-week there was a fair volume of trade.

At the Old Works the output of nails, billets, tin-bar, and steel sleepers continues large.

In the Swansea district the demand for bars has eased a little. An average make of steel was recorded last week.

At the Foxhole Works an unfortunate accident has happened to the rod crank and cylinder of the engine driving the sheet mills, which blocked business forthwith. Fitters were at once put on from the Millbrook Engineering Works, Landore, and it is expected that in a week or two repairs will be effected.

The tin-plate trade has been brisk. Last week the shipments amounted to 82,832 boxes. From the works the satisfactory total of 43,088 boxes came to hand, so that stocks are now down to 163,341 boxes, compared with 203,085 boxes this day week and 134,085 boxes at this date last year.

Operations were resumed at the Midland and Morriston mills on Tuesday. The twelve mills at the Worcester and Upper Forest have also been going well. The bulk of the plates, I find, turned out at the mills are black plates and "circles." Almost all the tin-plate establishments have now the circular machine shears for treating the latter. None of this class of plate, states a manager, is sent to be washed or dipped in any coating, the glaze for reflecting purposes being put on elsewhere. I hear that work at the tin houses is far from good.

No alteration has been recorded this week in iron and steel or tin-plate. Prices of pig iron are steady, with upward tendency. Last week Swansea imported 760 tons from Spain, a large quantity from Barrow, and 1263 tons scrap steel and 1970 tons iron ore. Tin is again advancing. Newport, Mon., was still more active in pig and ore imports. Amongst the principal items were 1000 tons pig iron from Middlesbrough, 250 tons from Workington, and 410 tons from Millom.

Unusually large cargoes of iron ore also came to hand at Newport last week, 3450 tons going to Blaenavon, 2100 tons to Ebbw Vale, and 1800 tons to La Société Commerciale. Cyfarthfa also had its usual average consignments of ore, and Dowlais was well looked after, also receiving a large cargo of spiegel iron from Workington. Amongst the Newport imports last week was 300 tons steel scrap from London.

The death is announced of Mr. Shepherd, pioneer of the Oakwood Colliery.

An engineering company is being formed at Bridgend.

Another feature of the Welsh water scheme for London has come to the front. A party of officials, representing London water companies, came to the Llangammarch valley last week, and are now occupied in gathering expert evidence in favour of the opposition.

The year is closing with conspicuous proofs of a restored coal and iron industry, and quite a promising outlook all around. The only qualifying signs are labour friction here and there, and the massing of forces in connection with the colliers. Miners' agents, at late meetings, have announced that they have succeeded in getting a large majority of Welsh colliers to join the Miners' General Federation, and early meetings in connection are announced for the New Year.

In the Swansea tin-plate district a tacit understanding seems to have been arrived at to go through the work at the present rate, namely, a concession of 15 per cent. off the standard. At Llanelly there are disturbing signs, which next week will allay or develope.

It has been decided by the Government to place an effective armament in the Bristol Channel, for the Cardiff ports in particular. Obsolete cannon are to be exchanged for those of great power and long range.

The Channel was visited by a great storm on Monday, and much damage done to shipping.

NOTES FROM GERMANY.

(From our own Correspondent.)

THE year is ending with undiminished briskness in nearly all departments of the iron and steel industry, and the coal and coke trade is likewise showing an increasing vigour, the tone all round being remarkably firm and hopeful.

Concerning the iron business in Silesia and Rheinland-Westphalia the position of the raw and finished iron trades is reported to be uncommonly satisfactory, but does not present any material change upon the week. Orders continue to come in freely, and an increase in employment can be stated in most branches; prices, as a rule, are tending upwards. The Silesian rolling mills, for instance, have raised their quotations M. 5 p.t. In crude iron a healthy trade is done, the supply not being quite equal to the demand. Much life is also stirring in the manufactured iron and steel industries; girders sell very briskly, and have been realising M. 135 p.t., even in cases where heavy contracts are in question. An extensive trade is done in plates, the heavier sorts meeting with specially good inquiry; long terms of delivery, ten to twelve weeks in many instances, are asked. The rail works have been securing so many orders lately that they were compelled to refuse a large Russian contract because they would not have been able to execute the order within the time stipulated.

The collieries of Silesia have yielded during the first two quarters of present year 10,578,069 t., against 9,604,518 t. for the corresponding period in the year before; the iron ore mines produced 198,902 t., against 209,834 t., and the zinc and lead ore mines 275,335 t., against 268,770 t. Production of the Silesian blast furnace works during the period above mentioned was 350,218 t., against 341,154 t.; the rolling mills and steel works produced 317,255 t., against 292,614 t.; and the raw zinc and zinc plate manufacturers produced 48,962 t., against 47,574 t. and 21,099 t., against 18,277 t. respectively. At the collieries the value of output sold amounted to M. 54,852,933, against M. 48,006,034; at the iron ore mines M. 1,361,289, against M. 1,147,244; at the zinc and lead ore mines M. 7,438,833, against M. 6,269,200; at the blast furnace works M. 5,273,331, against M. 5,323,854. Value of production sold by the manufactured iron and steel works amounted to M. 41,490,375, against M. 37,151,858, while the raw zinc and zinc plate manufacturers realised M. 17,948,097, against M. 15,784,511 and M. 8,029,807, against M. 6,232,743.

A total want of enterprising spirit and an uncertain feeling with regard to the future, continue the principal features of the Austro-Hungarian iron business. The trade done is entirely of the hand-to-mouth sort in all departments, consumers and dealers not buying more than is absolutely necessary. The railway and engineering trades are, on the whole, fairly well engaged, and have good prospects. The Hungarian State Railways have granted an order for 3000 wagons to the wagon factory at Ioh-Weitzer. Official quotations per ton, free Vienna, were last week as under:—Austrian and Styrian bars, 112fl. to 122fl.; Bohemian ditto, 110fl. to 114fl.; Hungarian ditto, 108fl. to 112fl.; girders, 111fl. to 125fl.; steel plates, 127fl. to 165fl., according to quality; heavy boiler-plates, 150fl. to 180fl. Styrian pig iron is quoted 45fl. to 51fl. p.t. at works.

In Belgium demand and consumption on the pig iron market continue satisfactory, and the business in manufactured iron has even been showing a slight improvement against previous weeks, and higher prices have, in some instances, been granted. The new steel works built by the blast furnace company Thy-le-Chateau, will begin operations in January, 1899; the same company is going to blow in a blast furnace at Wez Midi.

Current list rates for raw and manufactured iron during the week now past were:—Luxemburg foundry pig No. 3, 59f.; common forge pig, 52f. to 53f.; merchant bars, f.o.b. Antwerp, 132f. to 135f.; the same free Belgian Station, 135f. to 140f.; girders, f.o.b. Antwerp, 130f. to 135f.; the same free Belgian Station, 135f. to 140f.; iron plates for export, No. 2, 150f. to 155ft.; steel rails, 110f. to 120f., all per ton.

The French iron and steel trade has been active in most departments, the tendency of prices being unmistakeably in an upward direction. Paris dealers have been quoting 160f. to 165f. p.t. for merchant iron, and 175f. to 180f. p.t. for girders.

According to a note given by the *Wiener Montan Zeitung*, the total number of bicycles taxed in France in 1897 was 408,869, against 329,816 in 1896, 256,084 in 1895, and 203,026 in 1894. In 1897 the duty on bicycles yielded the sum of 4,060,800f., the greater part of this sum falling to the Department Seine. Only four departments—Nord, Seine-et-Marne, lower Seine, and Seine-et-Oise—yielded more than 100,000f., the smallest sum, 1760f., falling to the Department Lozère.

THE NEWPORT HARBOUR COMMISSIONERS' WEEKLY TRADE REPORT.

STEAM and house coal is rather quiet, as owing to the holidays many of the pits are only partially working. Prices remain same as last week. Exports for week ending December 14th were:—Patent fuel, 1700 tons; coal, foreign, 82,935 tons; coastwise, 25,195 tons. Imports for week ending December 27th were:—Pig iron 2860 tons; iron ore, 10,350 tons; pitwood, 6587 loads; scrap steel, 580 tons; scrap iron, 138 tons; one cargo deals and two cement.

Coal: Best steam, 11s. to 11s. 3d.; seconds, 10s.; house coal, best, 13s.; dock screenings 6s. 6d.; colliery small, 5s. 3d. to 5s. 6d.; smiths' coal, 7s. 6d. Pig iron: Scotch warrants, 49s 4½d. Hematite warrants:—Middlesbrough, No. 3, 44s. 5d. prompt; Middlesbrough hematite, 57s. 1½d. Iron ore: Rubio, 14s. 3d. firm; Tafna, 13s. 3d. to 13s. 6d. Steel: Rails—heavy sections—£4 10s. to £4 12s. 6d.; light ditto, £5 5s. to £5 12s. 6d. f.o.b.; Bessemer steel tin-plate bars, £4 12s. 6d.; Siemens steel tin-plate bars, £4 15s. All delivered in the district, cash. Tin-plates: Bessemer steel, coke, 10s. 6d. to 10s. 9d.; Siemens—coke finish—10s. 9d. to 11s. Pitwood: 17s. 6d. to 18s. London exchange telegram: Copper, £56 15s.; Straits tin, £84.

TRADE AND BUSINESS ANNOUNCEMENTS.—After nearly twenty-one years' as engineer to the Low Moor Company, Limited, Mr. Frederic J. R. Sutcliffe has arranged to leave at the close of the present year, and commence practice in Bradford as a consulting engineer, &c. —Messrs. Moses Eadon and Sons' London office has been removed to 5 and 6, Bishopsgate-street Without, London, E.C.

NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.—At a meeting of the above Society in Manchester on Wednesday last, Mr. E. S. Shoults read a paper on "Commercial Instruments for Indicating and Recording Electrical Quantities." The author dealt exclusively with instruments used in the commercial applications of electricity, as opposed to those used by physicists in the absolute determination of electrical and other quantities, and in the course of his remarks touched upon the question of foreign competition in connection with the production of instruments of the above description. English makers, he observed, could no longer neglect the fact that foreign instruments were far from being cheap rubbish that could be trusted to strangle itself. There was a cleanliness of finish and excellence of design and manufacture in German and American instruments especially, which we would do well to imitate. Type for type, and quality for quality, English instruments were cheaper than foreign ones; they were, however, not so cleanly finished, but were more substantial, and, taken all round, were more satisfactory than their foreign competitors.

ENGINEERING NOTES FROM SOUTH AFRICA.

(From our own Correspondent.)

SOUTH AFRICA will shortly provide some important orders for railway plant and material. The Transvaal Government has arranged a loan of two and a-half millions, a good deal of which will be expended upon railways. The Cape Railway vote this year is £1,850,698, the increase being principally due to heavy expenditure for rolling stock. A million for additional railways will shortly be asked for. Sir James Sivewright declares that the country really needs a railway loan of twenty-one mil ions. The engine drivers complain that the present inadequate stock of engines is being worked to death, and additional station accommodation is badly needed. Inefficient rolling stock partly accounts for the large proportion of accidents on the Cape railways.

With the extensive adoption of electrical power transmission in South Africa much difficulty has been experienced in protecting the plants against the terrible lightning storms of the country. In the new three-phase plant at Moodie's mine in the De Kaat field special provision has been made against lightning, and it is satisfactory to learn that it has now run for a year without having to stop through thunderstorms.

The cold-meat store concern at present running in Capetown is to be floated into a company in order to extend the enterprise and erect refrigerating plants throughout South Africa. Another company has been floated in the Transvaal with a capital of £95,000, and machinery has been ordered for two stores in Pretoria and Johannesburg respectively. The new rolling stock for the Cape Government Railways will include a number of refrigerating cars.

An advance of exceptional importance has undoubtedly been made of late years in the engineering practice of the Witwatersrand mines. Improved types of engines, boilers, and furnaces have been adopted, and surface condensing, feed-water heating, electrical transmission, and other means of fuel economy have been widely adopted. It is, however, rather surprising to find that the effect of this progressive engineering policy is sufficiently marked to influence the posi ion of the Republic's coal industry. Speaking at the annual meeting of the Transvaal Coal Trust the other day, the chairman complained that the consumption of coal on the Rand has not at all increased in proportion to the tonnage of ore milled. This fact, he admitted, is very gratifying as a demonstration of how carefully economy is studied in every part of the gold industry, but the mere shareholder in coal companies derives little satisfaction from such knowledge. One could hardly desire more striking testimony than this statement to the pecuniary value of up-to-date engineering methods, especially in a country like this, where dear labour and transport make the coal bill an expensive item of industrial costs. The chairman's views are fully confirmed by the annual report of the State Mining Engineer, which shows that the consumption of coal on the Witwatersrand gold mines in 1897 amounted to 2·59s. per ton of ore crushed, as against 3·36s. in 1896—a decrease of over 8d. a ton. This was the largest reduction shown in any item of mining or engineering supplies, except the food for the Kaffirs, and, after allowing for the decrease in the price of coal, there is still an appreciable part of it to be placed to the credit of enlightened engineering methods.

A valuable little industrial reform has just been carried in the First Volksraad of the Transvaal, that body having granted the Government and the Railway Commissioners authority to sanction the construction of branch lines between mines and the trunk system without application being made to the Rand. No fewer than forty such lines will at once be put in hand by virtue of this resolution. It applies only to private lines used exclusively for the carriage of fuel and ore, and not exceeding twelve miles in length.

In reference to a statement on page 403 of THE ENGINEER, I am indebted to Mr. Louis J. Seymour for some additional particulars concerning the rock-drill performance therein referred to. Mr. Seymour informs me that the trials mentioned took place on the Rose Deep property about June last. Not only is the statement of the 3½in. drill's work correct—26ft. 10½in. depth of hole in six hours—but this average was obtained with thirty-one drills, of the Ingersoll-Sergeant type.

PROPERTY IN DESIGN AND THE POSITION OF DRAUGHTSMEN.

IN the course of his presidential address recently delivered at the opening of the present session of the Institution of Engineers and Shipbuilders in Scotland, Mr. George Russell, of the well-known firm of engineers, Motherwell, gave outspoken expression to some ideas with respect to property in design which cannot but be read with interest by employers and draughtsmen alike, especially such as are engaged in mechanical engineering. After referring at length to the history and the educative effects of great international exhibitions, and the way in which the skill and experience involved in producing the exhibits shown there became disseminated among the nations, Mr. Russell proceeded to say that engineers who have become noted for excellence of design or workmanship, and who from experience and by careful study keep on improving their products, are not infrequently copied by others who originate nothing. The objects of industrial exhibitions and of institutions like our own are similar—to interchange ideas, and to contribute and receive information. So long as the giving and getting are mutual, and approximately balance, each exhibitor or author may be satisfied; but when the giving is not balanced by the getting, then the givers may justly complain. Those who exhibit their products, or read papers, and so invite comparison and criticism, are worthy of all commendation; but it should rest with the exhibitors or authors alone to fix how much they are willing to give away. Any attempt to obtain special information, or copy designs, without first obtaining the consent of the owner of the information or designs, deserved reprobation. The design of an efficient machine might be the result of many years of experience, careful study and calculation, and might even be held of more value than the materials and workmanship of which that machine was composed. It should therefore be considered as dishonest to copy the design without leave as to steal the materials of which it was composed. Property in design or invention should be honourably respected, whether protected by patent or not. There were many, unfortunately, who did not scruple to appropriate designs, and who would even use very questionable means to attain their object. It did sometimes happen when tenders were invited for a special machine, and designs were asked to be sent with the tenders, that the best design was not the lowest in price, and the lowest in price was not the best. But the purchaser being anxious to have the best bargain was tempted to offer the contract to the lowest offerer if he would make the machine to the best design. Another not uncommon circumstance was that a firm having purchased and used some special machine or appliance which had given every satisfaction, one or more were required; but instead of ordering from the engineer who designed and supplied the pioneer machine, tenders were asked from persons for the number required, and opportunity given to copy the first machine. The persons who by this arrangement obtained the design and data which they could not originate, could well afford to supply the machines at less than cost price. Yet another example of appropriation of designs might be mentioned, which was not unknown among boards, councils, or other public bodies. They required some special appliance, and entering into correspondence with some engineer, who was a well-known maker of what they wanted, asked all particulars, tender and specification, perhaps also a drawing. The engineer expecting to obtain the contract, gave them all they required, but after he had parted with his special information, instead of the order he received a circular letter that tenders were requested for the said appliances to be constructed according to the printed specification enclosed, which he discovered to be virtually the same specification that he had submitted himself, and was perhaps even illustrated by a "coloured" imitation of his own drawing. He then discovered that he had been acting as consulting engineer gratis in the public interest, and indirectly supplying information for the enlightenment of his trade rivals, who had been favoured with copies of the documents referred to. Many more typical examples of piracy could be cited, but these would suffice for illustrating how property in design was often appropriated without the consent and against the will of the owner. In pursuing still further this topic, the President gave expression to some opinions relative to the production of designs and the necessary calculations which were made in the drawing-office. In some cases the designs originated principally with the proprietors, in others with the manager, and in many with the draughtsman. It was manifestly the interest of the proprietors to retain possession as fully as possible of the designs originated in their establishment, whoever the designer might be. This led to the question, What was the draughtsman's position in this respect? He made the drawing either to the instructions of his superiors or on his own initiative, or partly both, which was perhaps the most usual way. If the machine was being designed of some new or improved type, it often happened that a great deal of time had to be devoted to every detail, and many alternative methods considered. Drawings were made, which were immediately superseded by newer drawings as the design developed, and alterations and improvements were discovered, requiring perhaps intricate calculations to be many times repeated, which altogether amounted to a considerable expenditure of time and money. This represented the cost of the design, whether the machine was successful or not. Its value depended on the success of the machine. If it fulfilled the object for which it was designed, and if there was a demand for similar machines, the design was at once imitated. One of the stratagems of the imitator was to entice the draughtsman to his employment, in order that he might thus obtain the coveted design, and so be able to compete with the engineer or firm who originated or bore the expense of the design, and whose property it was. Had the imitator, by employing the draughtsman, any right to expect a repetition of the design? Could the draughtsman honourably make a duplicate of the design? To what extent the design could be honourably reproduced would depend entirely on the position of draughtsman while the design was being originated. If he merely followed instructions in preparing the drawing, he had certainly no right to copy any part whatever, because the ideas were not his own. But if he alone was responsible for the design, being engaged as an expert, then he would be at liberty to scheme a similar machine for his new employer, although, if he acted honourably it could not be an exact copy; but, notwithstanding, it might be equally efficient and in all probability improved. No draughtsman or employé, under any circumstance, had any right to have in his possession, without special permission, copies of drawings belonging to his employer. But the draughtsman who worked intelligently would be observant of principles of construction, and try to understand the reason for variation in design. He did not require notes or sketches of actual dimensions, but, understanding fundamental principles, he was competent to design and did not require to copy. While urging the recognition of property in design and censuring those who were mere copyists, he did not mean to say that engineers were neither to look at nor consider the designs of other engineers. On the contrary, it was absolutely necessary, to save the time of the progressive engineer, that he should know what had been already accomplished; not to copy but to improve on what had already been done by others. His object was, or ought to be, to excel in whatever department he had chosen, and to keep on improving, not content with present achievements. If we were to maintain even our present position in engineering among the nations, we must fully recognise the competition we had to meet from all parts of the world. We should not be content to follow, but determine to remain among the leaders, originators, and the improvers.

THE PATENT JOURNAL.

Condensed from "The Illustrated Official Journal of Patents."

Application for Letters Patent.

**** When inventions have been "communicated" the name and address of the communicating party are printed in italics.

15th December, 1898.

26,334. ELECTRIC SWITCHES, W. J. Ferguson and W. G. H. Stump, London.
26,335. TELEGRAPHIC INSTRUMENTS, A. Muirhead, London.
26,336. ARRANGING a MAP, E. B. Waggett, London.
26,337. DRIVING GEAR for VELOCIPEDES, J. Neal, London.
26,338. ACETYLENE GAS LAMP, J. R. Palmer and E. Fisk, London.
26,339. VALVE, A. M. Stuart, London.
26,340. TOY, S. S. Dottridge, London.
26,341. HOOK, W. Bailey, London.
26,342. HEATING WATER, J. Y. Johnson.—(*W. S. Forbes, United States.*)
26,343. PLATES for SECONDARY BATTERIES, C. Brault, London.
26,344. HANDLE for HONES, J. Evans, London.
26,345. ROTARY SPITTOON, W. A. Burrow, London.
26,346. HOLLOW GLASS WARE, P. Jensen.—(*C. Z. F. Rott and T. C. Steimer, United States.*)
26,347. ACETYLENE GAS GENERATORS, J. H. Needles and H. W. Crozier, Kingston-on-Thames.
26,348. DERAILING RAILWAY CARS, E. Smyth, Kingston-on-Thames.
26,349. HOLDING NECKTIES in POSITION, A. E. Godwin, London.
26,350. DECORATING WOODEN SURFACES, H. Buyten, London.
26,351. GALVANIC BATTERIES, J. Wetter.—(*M. Maas, United states.*)
26,352. FOLDING BICYCLE, M. M. Türkheimer, London.
26,353. UMBRELLAS for VEHICLE DRIVERS, L. Vitton, Paris.
26,354. BINOCULAR GLASSES, J. Achieson, London.
26,355. BOAT-LOWERING DEVICES, G. S. A. Ranking, London.
26,356. CYCLE INFLATOR CARRIER, E. H. and H. Hill, Sheffield.
26,357. GATES, W. R. Pitt, London.
26,358. GUNS, F. A. Adcock, London.
26,359. SCREWS for ROOFING PURPOSES, F. A. Adcock, London.
26,360. BARRELS, V. Herold, S. C. Shattler, and G. H. Ricke, London.
26,361 AERIFORM FLUIDS, O. P. Ostergren and M. Burger, London.
26,362. ARMOUR for FLEXIBLE HOSE, H. H. Lake.—(*Asbest-Und-Gummiwerke Alfred Calson Actiengesellschaft, Germany.*)
26,363 BRAKES for BICYCLE, R. F. C. Scheewe, London.
26,364. PLATES for ARTIFICIAL TEETH, G. Poulson, London.
26,365. SETTING DIAMONDS, R. Krause, London.
26,266. FOG SIGNALLING, A. T. M. Johnson and W. M. Baynes, London.
26,367. CENTRIFUGAL FANS and PUMPS, S. C. Davidson, London.
26,368. DRYING YARNS, S. C. Davidson, London.
26,369. CUFF PROTECTORS, F. C. Watts, London
26,370. HOLDING BREAD when TOASTING, J. Wake, London.
26,371. CONTROLLING MECHANISM of VESSELS, N. Tesla, London.
26,372. STEAM MOTORS, H. D. and E. G. Paine, London.
26,373. LAST, J. Leclercq, London.
26,374. ROLLER BEARINGS, W. Balsch, London.
26,375. CHECKING WORKMEN'S TIME, F. W. Maas, London.
26,376. GAS ENGINES, W. P. Thompson.—(*A. A. Vanzickle and T. M. De Frees, United States.*)
26,377. TREATING TEXTILE PLANTS, C. L. Bachelerie, Liverpool.
26,378. BOXES, A. E. C. J. Behrendt. Liverpool.
26,379. ASH HOISTS, W. Railton, R. Campbell, and S. G. Railton, Liverpool.
26,380. ELECTRIC BATTERIES, E. Giglio, Liverpool.
26,381. CONDUITS for ELECTRIC CONDUCTORS, J. J. Bate, Liverpool.
26,382. FILTERS, A. Harris. Liverpool
26,383. TOY, H. S. F. Warth, Birmingham.
26,384. BICYCLE BRAKES, V. E. Doremus, P. T. Wall, and H. A. Siebrecht, London.
26,385. PNEUMATIC HUBS, E. C. Smith and C. W. Jefferson, London.
26,386. GAMES, M. D. Dexter, London.
26,388. WAIST-BANDS, O. Sieper, jun., London.
26,389. SIGNALLING, V. I. Feeny.—(*Allgemeine Elektricitäts-Gesellschaft, Germany.*)
26,390. PREPARING HIDES for TANNING, H. Holmes, London.
26,391. OXIDE of IRON, W. S. Rock, London.
26,392. MENTHOL CONES, A. W. Shirley, London.
26,393. SOLDERING ALUMINIUM, T. C. V. de Stadt, London.
26,394. CIGARETTE CASES, A. J. and W. C. Needham, London.
26,395. FEED-WATER HEATERS, C. E. Ferreira, London.
26,396. STOPPING VEHICLES, H. L. Webster and H. J. Norballe, London.
26,397. ACID-PROOF MATERIAL, C. Jung, A. Brecher, and A. Kittel, London.
26,398. VEHICLES, G. Gibson and J. Montgomery, London.
26,399. CIGAR HOLDERS, H. B. Fitz-Simon and K. E. Ellis, London.
26,400. RAMMERS for FOUNDRY MOULDS, J. C. Cramp, London.
26,401. BATH APPARATUS, C. E. Schnée, London.
26,402. STOP-MOTIONS for LOOMS, J. G. Herrlinger, London.

14th December, 1898.

26,403. WASTE-WATER CLOSETS, J. Day, Wolverhampton.
26,404. THREADING SHUTTLE, F. Chadwick, J. Healey, and J. D. Ingham, Heywood.
26,405. BODIES for ROAD VEHICLES, C. G. McDowell, Warrington.
26,406. FILTER-BED CONSTRUCTION, S. H. Adams, Harrogate.
26,407. TOOL HOLDERS, J. Walker, Leeds.
26,408. IRONING MACHINE, A. J. Mieras and R. A. Craig, Edinburgh.
26,409. WINDING FRAMES, R. and E. Sykes, Huddersfield.
26,410. SIGNALLING, W. H. Yates and J. Haigh, Manchester.
26,411. SPINNING FRAMES, J. Barbour, Halifax.
26,412. TERMINAL for ELECTRICAL FITTINGS, J. Stoddart, Halifax.
26,413. STEP-LADDER HINGES, C. Fulford and G. F. Manion, Birmingham.
26,414. QUARRYING of GRANITE FREESTONE, A. Mann, Glasgow.
26,415. HEATING CONSERVATORIES, W. Oliphant, Glasgow.
26,416. VALVE for CONTROLLING GASES, A. B. Willway, Bristol.
26417. LETTER-COPYING DEVICES, S. H. Crocker, London.
26,418. LETTER-COPYING BOOKS, S. H. Crocker, London.
26,419. DYNAMO-ELECTRIC MOTORS, H. and W. Humphreys, Manchester.
26,420. FUSIBLE CUT-OUTS, C. M. Dorman and R. A. Smith, Salford.
26,421. SEWING-MACHINE TRIMMERS, J. K. Macdonald.—(*The Singer Manufacturing Company, United States.*)
26,422. CARDBOARD BOXES, G. E. Washington, Manchester.
26,423 GOVERNOR for STEAM ENGINES, W. Shinn, Liverpool.
26,424, WROUGHT IRON FLANGES, A. E. Jenks, Wolverhampton
26,425. CHURNING MILK, R. Austin, Glasgow.
26,426. MICROMETER, C. J. Banks, Newcastle-on-Tyne.
26,427. OIL-CANS, H. R. Walker, Liverpool.
26,428. JOINT for STEAM PIPES, F. E. Walker, Yeadon, Yorks.
26,429. EMBROIDERING MACHINES, J. Entwisle.—(*The Kursheedt Manufacturing Company, United States.*)
26,430. PENHOLDER, F. C. Edgar, Bristol.
26,431. RECEPTACLE for HOLDING SOAP, A. W. McQueen, Glasgow.
26,432. OUTSIDE STOP TAPS and BOXES, J. Penney, Manchester.
26,433. OPENING WATERTIGHT DOORS, F. T. Cooper, Altrincham.
26,434. DRYING WHITE LEAD, H. C. Webster and T. French, Glasgow.
26,435. CONDUCTING PHOTOGRAPHIC OPERATIONS, C. Raleigh, London.
26,436. CHECK STRAP END for LOOMS, J. Buller, Brierfield, Lancs.
26,437. DRIVING GEAR for VEHICLES, A Craig, London.
26,438. BOOTS and SHOES, G. H. and A. W. Faire, London.
26,439. COMMUNICATION BETWEEN PASSENGERS and GUARD of TRAINS, E. Edwards and T. Kitson, London.
26,440. ROTARY SPINNING MACHINE, H. Edgar.—(*Ding Cie Sing, G. S. Miner, and —— Brewester, China.*)
26,441. INLAID CERAMIC ART DECORATION, H. Procter and H. Taylor, London.
26,442. EXPLOSION MOTOR ENGINES, T. W. Marshall, London.
26,443. ORTHOPEDIC and SURGICAL BANDAGES, V. Petitfils, London.
26,444. GAS as a MOTIVE POWER, F. A. Parnell, J. Thomas, and F. C. Sydney, London.
26,445. BOXES, &c., J. Bonner, London.
26,446. DRIVING GEAR for BOATS, E. A. Storer, Lynmouth, North Devon.
26,447. PRESERVING PROPELLER SHAFTS from WATER CUTTING, G. W. de Tunzelmann, London.
26,448. TEA BOTTLES, J. C. Leigh, Twickenham, Middlesex.
26,449. CREATING POWER for DRIVING MACHINERY, C. W. Wood, London.
26,450. MAKING SALT from BRINE, G. W. Handscomb, Birmingham.
26,451. SCALE BEAMS, G D. Howard.—(*J. A. Fleming, United States.*)
26,452. DRIVING GEAR for CYCLES, &c., C. L. Carson, London.
26,453. DOFFING APPARATUS, E. Edwards.—(*E. Kornkuber, Russia.*)
26,454. REGULATING AIR to FURNACES, F. Marcotty, London.
26,455. CYCLE BRAKES, R. Rainsford.—(*W. J. Hinkson, United States.*)
26,456. FORGING ARTICLES of SPHERICAL SHAPE, G. H. Hathorn, London.
26,457. ORE-CRUSHING MACHINERY, R. Rainsford.—(*F. H. Cook, United States.*)
26,458. COLLECTORS for ELECTRIC TRAMWAYS, R. Rainsford.—(*J. Welsh, United States.*)
26,459. BARREL COVERS, C. Bloomingdale, London.
26,460. INSOLE for BOOTS, W. Harmer, London.
26,461. PAPER-PERFORATING MACHINES, T. J. Heap, London.
26,462. AUTOMATIC CONCEALED SPRING SEAT PILLAR, J. Hodgon, Birmingham.
26,463. RECEPTACLE for UMBRELLAS, C. J. Coleman, London.
26,464. OUTDOOR SEATS, R. L. Roberts, J. Brooks, L. G. Trundle, J. Angus, and R. O. Backhouse, London.
26,465. RECEPTACLE for BLACKING, R. Bowen, London.
26,466. WATER-CLOSETS, R. Fyfe, London.
26,467. FENDER for PROTECTION against COLLISIONS at SEA, W. P. Thompson.—(*F. G. Nielsen, Germany.*)
26,468. CONSTRUCTION of HOUSES, W. P. Thompson.—(*D. Judson, Rhodesia.*)
26,469. CONVEYING COAL to GAS PRODUCERS, E. Bennis, Liverpool.
26,470. TREATING HIDES, J. Hutchings, Liverpool.
26,471. CINEMATOGRAPH APPARATUS, V. Crescenzi, London.
26,472. FIRE-BOXES for STEAM BOILERS, J. Heutschel, London.
26,473. CONVERTING RECIPROCATING MOTION, C. D. Abel.—(*La Compagnie Generale des Compteurs—Société Anonyme—Belgium.*)
26,474. INCANDESCENCE LAMPS, L. Denayrouze, London.
26,475. PURIFYING SACCHARINE LIQUORS, E. and S. G. Luck, London.
26,476. BATTERIES, C. E. Burroughs, Washington, United States.
26,477. CALCIUM CARBIDE, J. d'Orlowsky, London.
26,478. RUBBER TIRES, C. R. Cloake, London.
26,479. ELECTRICITY METERS, G. Hookham, London.
26,480. CASES for BALLS of THREAD, R. H. J. Wahrlich, London.
26,481. STEAM GENERATOR, J. Eder, London.
26,482. REDUCTION of FRICTION of AXLES, W. J. Brewer, London.
26,483. REDUCTION of FRICTION of AXLES, W. J. Brewer, London.
26,484. ADJUSTABLE BRAKE for BICYCLES, E. M. Wildey, London.
26,485. INCANDESCENT LAMPS, E. Murmann and A. Opawski, London.
26,486. COOLING the STOKEHOLDS of SHIPS, M. Robitschek and L. R. von Herz, London.

15th December, 1898.

26,487. CORSETS, R. Neilson, London.
26,488. INCANDESCENT GAS BURNERS, J. Wilson, Birmingham.
26,489. The BONFIRE BUNDLE WOOD, D. Lewes, Bournemouth.
26,490. NON-SLIPPING TIE COLLAR, H. S. Poll, Great Yarmouth.
26,491. METALLIC PACKINGS for PISTON-RODS, J. Butterworth, Manchester.
26,492. PIPE CLEANER, J. W. Carmichael, Workington, Cumberland.
26,493. SINGLE TRIGGER DOUBLE-BARREL GUNS, C. O. Ellis and E. W. Wilkinson, Birmingham.
26,494. ELECTRICAL SWITCHES, A. Watson, Birmingham.
26,495. TROLLEY or BARROW, A. W. Williams, Bristol.
26,496. FILE BOXES, A. E. Walker, London.
26,497. METALLIC TOE-CAP, M. Gutmann, A. Levy, and A. Hauser, Baden, Germany.
26,498. PREVENTING the DEFORMITY of HUMAN TOES, H. J. Pond, Birmingham.
26,499. COKING STOKERS, J. Proctor, Manchester.
26,500. PAPER, A. Masson, London.
26,501. PAPER-MAKING MACHINERY, A. Masson and F. Scott, London.
26,502. METALLURGICAL PROCESSES, A. S. Plews and J. W. Worsey, Manchester.
26,503. NON-FILLABLE BOTTLES, A. Taylor, Vancouver, British Columbia.
26,504. TIRES, W. Marvin, Bristol.
26,505. COMBUSTION MOTORS, H. T. and H. A. Dawson, Coventry.
26,506. MATTRESSES, A. Lakin, Birmingham.
26,507. MUSICAL INSTRUMENT CASES, A. O. Windsor, Birmingham.
26,508. ADJUSTING VENTILATORS, R. R. Harrison, Birmingham.
26,509. TRICYCLES, J. Greffe, Glasgow.
26,510. CENTRE FINDER for UMBRELLA STICKS, T. Pell, Ilkley, Yorks.

26,511. SHIPS' HATCH CLEAT, W. Walker, jun., Maryport, Cumberland.
26,512. BENDING METAL PIPES, C. Bollé.—(*G. Brandt, Germany.*)
26,513. PLUG, A. D. Ash, Willenhall.
26,514. GARDEN LAWN ROLLERS, J. B. Summerscales, Keighley.
26,515. CREATING DRAUGHT, J. E. Weyman, Manchester.
26,516. MOTORS, S. J. Williamson, Liverpool.
26,517. "THE" AUTOMATIC LIFT DOORS, A. Sear, London.
26,518. GASEOUS FLUID PRESSURE MOTOR, J. Fraser, London.
26,519. INK-SUPPLY APPARATUS, W. H. Dawson and J. Stott, London.
26,520. ADVERTISING DESK, H. A. Pooley and F. Cabot, London.
26,521. TROUSER FASTENINGS, H. A. Pooley and F. Cabot, London.
26,522. BEARINGS, A. J. Boult.—(*A. C. Smith, United States.*)
26,523. NEWSPAPER HOLDERS, G. A. Witt, London.
26,524. SEWING MACHINES, T. J. Roome, P. Whitney, and W. Graaff, London.
26,525. FILTER, W. O. E. Meade-King, London.
26,526. CRUCIBLE for CASTING LEAD, &c., E. J. Clark, London.
26,527. REGULATORS for ELECTRIC CAR MOTORS, H. H. Lake.—(*H. S. Maxim, United States.*)
26,528. POWDER DISTRIBUTORS, E. E. McMorran, London.
26,529. SMOKELESS GUNPOWDER, F. A. Halsey, London.
26,530. RIMS and INFLATABLE TIRES, A. Pulbrook, London.
26,531. REDUCING ORE by OZONE D. Martini, London.
26,532. BRICKLAYERS' STOCK TOOL, J. B. House, London.
26,533. PRODUCING CARBURETTED AIR, H. Rey, London.
26,534. GAS BURNER GOVERNOR, E. Forbes, Tonbridge.
26,535. ACETYLENE GAS SIGNAL LAMP, St. J. B. Headley, London.
26,536. DECANTER, W. P. Thompson.—(*G. Bonnefont, France.*)
26,537. BARRELS, J. H. J. Bartels, Liverpool.
26,538. CYCLE SADDLES, W. H. Fox and H. H. Bissell, Birmingham.
26,539. TREATMENT of OILS, C. de la Roche, London.
26,540. EXPLOSION MOTORS, A. Fiernhofer, London.
26,541. COIN-FREED APPARATUS, H. H. Lake.—(*P. C. Shaffer, United States.*)
26,542. CRATES for PACKING RABBITS, W. A. Thompson, London.
26,543. SMOKE-CONSUMING APPARATUS, W. A. Granger, London.
26,544. BUCKLES, E. E. Beegiemyer, London.
26,545. WALLS, T. Küpper, Germany.
26,546. SAFETY RAZOR, H. J. Haddan.—(*M. Finn, United States.*)
26,547. DECORATED GLASS SHEETS, P. T. Sievert, London.
26,548. TAPS, T. Settle and W. A. Padfield, London.
26,549. STEAM ENGINES, T. W. Scott, London.
26,550. CUFF-LINKS, J. Cross, London.
26,551. TOOTH-BRUSHES, J. and A. Bidwell and T. A. Young, London.
26,552. POLISHING WHEELS, J. Thornton and T. R. Canning, London.
26,553. LADIES' NECK-WEAR, E. A. Roskilly, London.
26,554. MANUFACTURE of SLABS, E. Baubil, London.
26,555. PNEUMATIC TIRES, F. Toni, London.
26,556. HUNTING COAT, T. H. Holding, London.
26,557. COPYING APPARATUS, H. Krandt, London.
26,558. CLOSING DOORS, J. Preston, London.
26,559. PHONOGRAPHS, L. Rosenthal, London.
26,560. BRUSHES, F. G. Farnham, London.
26,561. FRAMES for MOUSTING FLOWERS, E. Piper, London.
26,562. WIRE ROPEWAYS, P. Jensen.—(*W. Kem'o, India.*)
26,563. CYCLES, &c., E. Levison and C. I. Steiner, London.
26,564. BUTTON, J. W. Plunkett, London.
26,565. PRINTING FRAMES, G. C. Marks.—(*M. Deloye, France.*)
26,566. TELEPHONE TRANSMITTERS, F. H. W. Higgins, London.
26,567. CYCLE GEAR, J. C. Bromfield, London.
26,568. FOOD PREPARATIONS, H. Ballantyne, London.
26,569. LAMPS, T. C. J. Thomas, London.
26,570. BEAKING APPARATUS for WAGONS, G. Labram, London.
26,571. LADIES' DRESS FASTENER, E. M. Sample, London.
26,572. REGULATING WINDOW SASHES, J. C. Moore, Eastbourne.

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26,573. FASTENERS for DOORS, &c., W. Mullan, Belfast.
26,574. YARN-WINDING MACHINERY, J. D. Whyte and Whyte's Patents, Limited, Manchester.
26,575. MONEY-REGISTERING TILL, W. Haynes, F. Hewitt, and F. E. Bradley, Manchester.
26,576. REMOVING HAIR from SKINS, S. L. and E. Johnson, J. Brookstank, and A. H. Gibbings, Bradford.
26,577. LABELLING MACHINES, J. H. R. Dinsmore, Liverpool.
26,578. MOVABLE SIGNS for ADVERTISING PURPOSES, W. I. Chadwick, Manchester.
26,579. SELF-CLOSING WATER VALVE, H. B. Barlow.—(*J. Campbell, Ceylon.*)
26,580. BRAKE for RAILWAY PLATFORM TRUCKS, G. Comber, Manchester.
26,581. GAS ENGINES, J. M. Hetherington, Manchester.
26,582. POCKET KNIVES, T. H. Gibbins and J. C. Powell, Sheffield.
26,583. SCISSORS, T. H. Gibbins and J. C. Powell, Sheffield.
26,584. GAS and OIL ENGINES, J. Walton, Sheffield.
26,585. WATER-WHEELS, E. B. Taylor, Manchester.
26,586. MUSIC STOOLS, J. P. McPhun, Glasgow.
26,587. ARTIFICIAL IVORY, J. Westaway, London.
26,588. PRODUCING EMBOSSMENTS in CAMEO in FIBROUS PULP, J. Westaway, London.
26,589. COLLAPSIBLE UMBRELLAS, H. Haegermann, Berlin.
26,590. DRIVING CHAINS and WHEELS, H. Renold, Manchester.
26,591. TUBULAR CORK, J. T. Parnell, Portsmouth.
26,592. NAIL-MAKING MACHINES, C. March and W. Haggo, Glasgow.
26,593. METALLIC COIL SPRINGS, W. Drummond, Glasgow.
26,594. HOLDERS for CIGARETTES, T. Lloyd, Risca, Mon.
26,595. AUTOMATIC VOTE RECORDER, H. Symonds, Dorchester.
26,596. INTERNAL COMBUSTION ENGINES, M. H. C. Shann, London.
26,597. FURNACES for HEATING RIVETS, F. Tyers, London.
26,598. BRAKE APPARATUS for CYCLES, T. A. Hanson, London.
26,599. CIGAR CASE, J. Biesenbach, London.
26,600. ENDLESS BLOCK TACKLE, J. Smith and G. Scouton, London.
26,601. BICYCLE HANDLE-BAR JOINT, W. H. J. Grout, London.
26,602. MACHINES for DYEING YARN, W. Coventry, Manchester.
26,603. APPARATUS for PRODUCING MOTIVE POWER, J. Gill, London.
26,604. TELEPHONE APPARATUS, F. W. Francis, London.
26,605. GRATERS, W. J. Curry, Kingston-on-Thames.
26,606. SOLE-INKING MACHINES, G. W. Palmer, Kingston-on-Thames.
26,607. TOYS, H. M Paget, London.
26,608. BOTTLES, F. C. Rylands and M. H. Durst, London.
26,609. LANTERN SLIDE, C. F. Townsend, Ightham, Kent.
26,610. LAMPS, R. E. B. Crompton and E. A. N. Foshin, London.
26,611. CAKE STAND, Elkington and Co., Limited, and H. T. Fellows, London.
26,612. LEVER STOPPERS for BOTTLES, C. H. Brown, London.
26,613. APPARATUS for HEATING WATER, H W. Bowden, London.
26,614. TREATING ORES by ELECTROLYSIS, J. A. Mays, London.
26,615. ENGINES for CARDING COTTON, L. A. Porritt, Manchester.
23,616. ACETYLENE GAS, M. Strakosch and F. Schmidt, London.
26,617. PURIFICATION of INDIA-RUBBER, H. B. de Laqueuille, London.
26,618. TABLES, W. P. Thompson.—(*Boetch Bros. and Co., Canada.*)
26,619. SWITCHBOARDS, W. P. Thompson.—(*T. F. Ahern, United States.*)
26,620. SHAPING SHOULDERS of GARMENTS, G. Goldman, Liverpool.
26,621. PHONOGRAPH, E. Parise, Liverpool.
26,622. SACKS, E. E. Levy, Liverpool.
26,623. DRAUGHT ROPES of STEAM TRAWLERS, W. B. Brown, Liverpool.
26,624. RELEASING DRAUGHT ANIMALS from VEHICLES, A. S. Sullivan, London.
26,625. COLOURING MATTERS, G. B. Ellis.—(*La Société Chimique des Usines du Rhône anciennement Gilliard, P. Monnet et Cartier, France.*)
26,626. STEAM BOILERS, T. Thompson, London.
26,627. TYPEWRITER, W. N. Blake, London.
26,628. ACETYLENE GENERATING APPARATUS, J. S. Goodwin, London.
26,629. CURRENT COLLECTORS, E. Penning-Dupuis, London.
26,630. HOLDING GROUNDSEL in BIRD CAGES, W. I. Armstrong, London.
26,631. CORSETS, H. A. Sisley, London.
26,632. FLUSHING CISTERNS, G. Hoskins, London,
26,633. CANISTERS, H. Higginson, London.
26,634. DROP LATCH, W. Dudley, London.
26,635. ANIMAL TRAP, C. Bender, London.
26,636. DOFFING DEVICES for CARDS, C. O. Liebscher, London.
26,637. FLEECE FEEDING of CARDS, C. O. Liebscher, London.
26,638. CYCLE-DRIVING GEAR, A. Cuthbert, London.
26,639. PRODUCING METHYL-MORPHINE, E. Kander, London.
26,640. WOOD-WORKING APPARATUS, A. and A. Bossard, London.
26,641. ADJUSTABLE SPANNER and PIPE WRENCH, F. Nikles, London.
26,642. SUPPORT for RAILWAY SIGNAL WIRES, A. G. Evans, London.
26,643. SUPPORT for RAILWAY SIGNAL WIRES, A. G. Evans, London.
26,644. PIPE JOINTS, E. Putzeys, London.
26,645. SOFTENING and CLARIFYING WATER, W. Lawrence, London.
26,646. CRUCIBLE FURNACES, R. Baumann, London.
26,647. UTILISING HEAT, R. Haddan.—(*J. E. Whiting, India.*)
26,648. GLASS-POLISHING MACHINES, F. F. Fischer, London.
26,649. CONTROLLING SWITCHES, Siemens Bros. and Co., Limited.—(*Siemens and Halske Aktiengesellschaft, Germany.*)
26,650. BURNERS for ELECTRIC LAMPS, — Andreas, London.
26,651. CARRIER for ACETYLENE GAS, G. S. Bush, London.
26,652. INDICATORS for VELOCIPEDES, H. L. Peyer, London.

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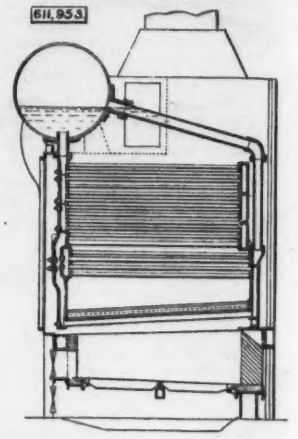
26,653. BOTTLE, S. Radlaner and P. and A. Schroedter, London.
26,654. BOTTLES, S. Radlaner, and P. and A. Schroedter, London.
26,655. VALVES for CYCLES, E. Dagain and — Vergé, London.
26,656. HEAD RESTS, P. Gusdorf and D. Elkan, London.
26,657. NEW GAME of TUMBLERS, C. R. Mitchell, London.
26,658. INSTANTANEOUS STEAM GENERATORS, W. Simpson, W. L. Bodman, and D. H. Simpson, Manchester.
26,659. WATER PIPES, W. E. Bryan, Lyndhurst, Hants.
26,660. DECORATING CERAMIC-WARE, J. Hobson, Stoke-on-Trent.
26,661. FIXING TILES to ROOFS, J. Pickford, Newport, Mon.
26,662. FANLIGHT OPENERS, G. F. Newman, Birmingham.
26,663. SHOES, R. A. Rogers and G. A. Innocent, Newport, Isle of Wight.
26,664. PRESSURE TUBES, W. Raine, Stockton-on-Tees.
26,665. INCANDESCENT GAS BURNERS, J. Jackson, Coventry.
26,666. FRAMES for SPINNING MACHINES, E. Harwood, Halifax.
26,667. MARKING CLOTH, F. Lehmann and A. van Kempen, Manchester.
26,668. TIRES for WHEELS of VEHICLES, J. W. Taylor, Huddersfield.
26,669. LAMPS, A. W. Turner and J. Adie, Birmingham.
26,670. FIXING RAILWAY LINES, H. P. Farrer, Bradford.
26,671. ADVERTISING FACIA, G. Cotton, Manchester.
26,672. BELT PULLEYS, A. E. N. and S. N. Yeadon, Leeds.
26,673. LOCKING DEVICE for TRUCKS, H. H. Frost, Manchester.
26,674. MANUFACTURE of HATS, A. Oldham, Manchester.
26,675. ADVERTISING, W. Messer, Glasgow.
26,676. CORK SCREWS, T. D. Read, Glasgow.
26,677. GRAVITY ESCAPEMENT MECHANISM, A. Preston, Leigh, Lancs
26,678. FRICTION CLUTCHES, J. B. Thompson and J. Smith, Glasgow.
26,679. RAILWAY PLATFORM TROLLEYS, H. Buckley, Manchester.
26,680. SIZING APPARATUS, H. and J. H. Martin, Manchester.
26,681. ATTACHMENT for PADALS of CYCLES, R. W. Sale, Derby.
26,682. CHEMICAL MANURE, C. G. T. Dixon, J. Crone, D. C. Taylor, and F. Williams, Liverpool.
26,683. STOPPERS for WATER BOTTLES, J. Martin, Liverpool.
26,684. KEYED TILE, W. W. Gravill, Leeds.
26,685. TRAPS for THROWING FRANGIBLE TARGETS, A. J. Boult.—(*The Cleveland Target Company, United States.*)
26,686. HOISTING and LOWERING BOATS, J. Thomson, London.
23,687. SAFETY WINDOW for CARRIAGES, H. Reed, London.
26,688. PUMPS for GASEOUS BODIES, J. N. Hochgesand, London.
23,689. CONNECTIONS in BOXES, J. Temler, London.
26,690. CANS, R. G. Newton, J. T. Shakespeare, and W. Hunt, Birmingham.
26,691. ACETYLENE LAMP, C. Lyons, Ballinfull, Co. Sligo.
26,692. PAINTING MOPS and SCRAPERS, G. F. Rastall, London.
26,693. BOTTLES for VOLATILE LIQUIDS, H. Goets, London.
26,694. PAPER, J. Rowley, London.
26,695. SECONDARY BATTERIES, W. Puttkammer, London.
26,696. SCALING LADDERS for CHIMNEYS, H. Heinicke, London.
26,697. COMPRESSION of GASES, &c, W. T. Sugg, London.
26,698. TONGS, J. Jackson and W. R. E. Alexander, London.
26,699. INDICATING the LEVEL of WATER, J. Murrie, Glasgow.
26,700. APPARATUS for COATING METALS, F. H. Snyder, London.
26,701. SADDLES, A. M. Ross and E. L. Cantwell, London.
26,702. SCREW PROPELLERS, F. W. Lanchester, London.
26,703. PRIMARY BATTERIES, H. T. Harrison, London.
26,704. CAMERAS, H. Röhrich and L. Scharrelmann, London.
26,705. DRAWER, C. Vogt, London.
26,706. CABLE LIGHTNING CONDUCTOR, J. Boens, London.
26,707. SYNCHRONISING CLOCKS, A. Zeschall and C. Resch, London.
26,708. EXPLOSIVE SHELLS, D. M. Mefford, London.
26,709. FURNACE GATE, C. D. Abel.—(*Pallitzer and Co., Austria.*)
26,710. DOUBLE-ACTION LOCK for CASES, P. T. Johnson, London.
26,711. CRATES, W. P. Thompson.—(*Litzelmann and Tmsler, France.*)
26,712. WARMING the CONTENTS of FOOD CONTAINERS, W. P. Thompson.—(*S. Schreiber and B. Schwersen, Germany.*)
26,713. VALVES, R. S. Watson, F. H. Durell, and M. B. Miller, London.
26,714. BRAKE, A L. Pettersson and K. J. Karlqvist, Liverpool.
26,715. PNEUMATIC TIRES for WHEELS of VEHICLES, F. Meredith-Jones and A. Seymour-Jones, Manchester.
26,716. TIRES for WHEELS of CYCLES, E. Y. Walsh, Manchester.
26,717. PROCESS of SOLDERING, F. Chaist, London.
26,718. REDUCING FIBROUS MATERIALS, J. Wüstenhöfer, Barmen, Germany.
26,719. SAWING MACHINES, La Société des Aciéries de Longwy, London.
26,720. BASKETS, J. G. Karg, London.
26,721. ENGINES, P. Bailly, London.
26,722. TAKING PHOTOGRAPHIC VIEWS, C. Raleigh, London.
26,723. INDICATOR for ELECTRIC CURRENT, W. E. Burnand, London.

SELECTED AMERICAN PATENTS.

From the United States Patent-office Official Gazette.

611,953. WATER-TUBE STEAM BOILER, *H. Workman, Dullatur, Scotland.—Filed May 21st*, 1898.

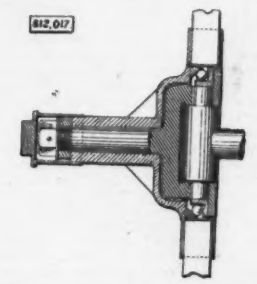
Claim.—(1) In a water-tube steam boiler, a stack of horizontal or slightly-inclined tubes in two portions, an upper and a lower portion, the tubes in the upper portion being connected with each other to form continuous zigzag or backward and forward and generally downward passages from the uppermost tubes, a water and steam drum, to the lower part of which the uppermost tubes are connected, the lowermost tubes of the upper portion of the stack being connected with the lowermost tubes of the lower portion, and the uppermost tubes of the lower portion being connected to the water and steam drum, while the uppermost and lowermost and intermediate tubes of the lower portion are connected with each other to form zigzag or backward and forward passages, the flow of water being downward through the upper portion and upward through the lower portion of the stack, substantially as herein set forth. (2) A water-tube steam boiler comprising a stack of horizontal or slightly-inclined tubes connected with each other, the lowermost tubes being at a distance below the next higher tubes to form a combustion space, with a furnace space and a lateral flue on one side or on each side connecting the said furnace space with the combustion



space, the said lowermost tubes having their interstices closed, as and for the purpose herein set forth.

612,017. STEERING-WHEEL for MOTOR VEHICLES, *E. J. Clubbe and A. W. Southey, London, England.—Filed March 23rd*, 1897.

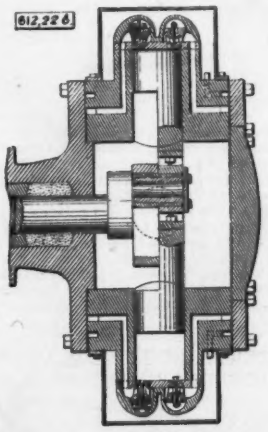
Claim.—(1) The combination, with a centrally-pivoted steering wheel, having vertical pivoting points within the bearing on which the wheel rotates, of a solid lateral extension of such bearing, forming,



together with a corresponding hollow extension of the hub, an auxiliary bearing of smaller diameter, for the purposes described. (2) The composite ball and sliding bearing for a centrally-pivoted wheel, substantially as and for the purposes described and shown.

612,226. AMMONIA-GAS COMPRESSOR for ICE MACHINES, *J. J. Bailey, New York, N.Y.—Filed August 27th*, 1896.

Claim.—(1) In an ammonia-gas compressor, the combination with the body A having an open centre and four cylinders and pistons at right angles to each other and in the same plane, of pistons and valves in the entrance and exit passages, a shaft and crank connected therewith, and a crank pin, the slotted yokes g and g', the slide block around the crank pin and moving in said yokes, the inner ends of the pistons being half cylinders and connected by the



yokes in pairs so that the space occupied by the two yokes is equal to the width of the pistons, and the pistons are in the one plane and operate progressively, substantially as set forth. (2) In an ammonia-gas compressor, the combination with the body A having an open centre and passages therethrough, of the oil trap l and the oil reservoir m, a pipe 7 having a check valve connecting the oil trap and oil reservoir, a pipe 8 from the bottom of the oil reservoir to one of the passages through the body of the machine, a pipe 9 from the oil trap, and a pipe 10 having a valve and extending from the top of the oil reservoir and opening into the ammonia suction pipe i', substantially as and for the purposes set forth.

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